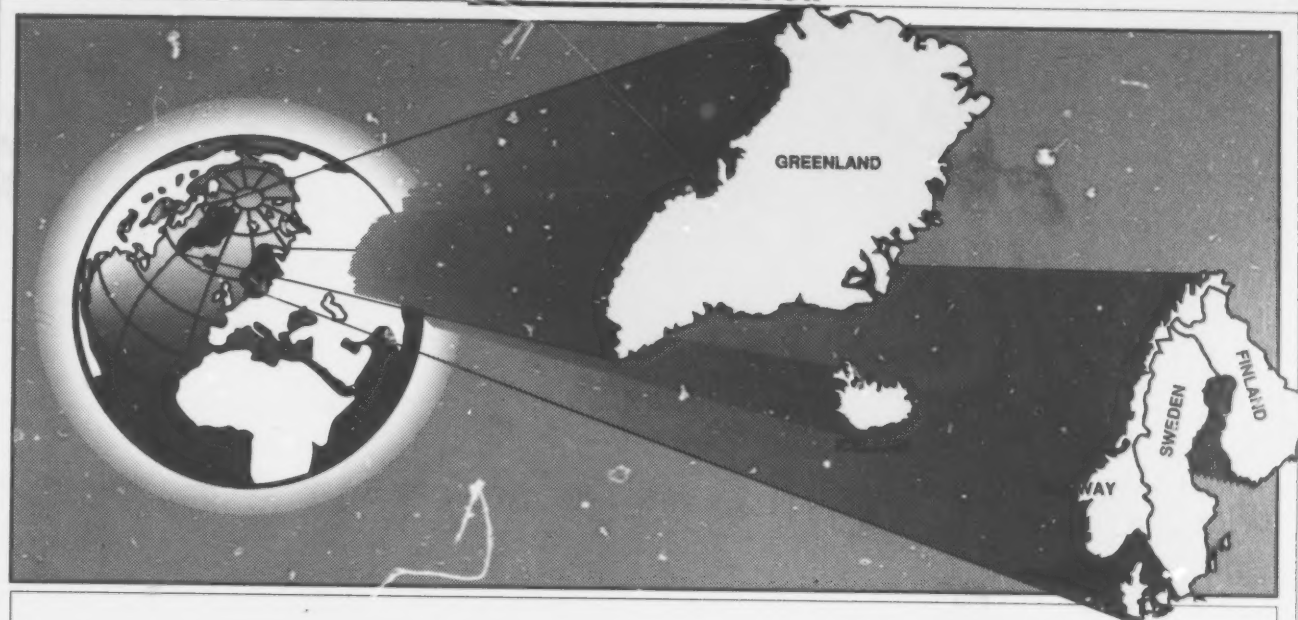


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MINERALS YEARBOOK



THE MINERAL INDUSTRIES OF

SCANDINAVIA

By Donald E. Buck, Jr., and Harold R. Newman

1988

INTERNATIONAL REVIEW

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

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THE MINERAL INDUSTRIES OF

SCANDINAVIA



U.S.
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Secretary



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THE MINERAL INDUSTRIES OF SCANDINAVIA

By Donald E. Buck, Jr., and Harold R. Newman

DENMARK¹

The value of Denmark's oil and gas industry from North Sea production was approximately \$2.9 billion² in taxes and supplied 40% of the energy needs of the country. The only significant metals industry was the Danish Steel Works Ltd., a steel plant based on scrap. Significant industrial minerals were cement, diatomaceous materials, and crushed and dimension stone.

Denmark's production of North Sea oil and gas continued to increase significantly and provided more than 70% of the country's petroleum requirements. The major objective of the Government's energy policy continued to be the reduction of net oil imports and encouragement of the development of the country's indigenous sources of oil. Development of the North Sea petroleum resources continued, but at a slower rate because of near saturation of the gas market, low oil prices, and estimated oil reserve limitations.

Austere measures taken by the Danish Government to limit domestic consumption and encourage exports in previous years, resulted in the stagnation of the consumer economy and an increase in the gross domestic product (GDP) of only .2%. Unemployment increased while private investment decreased as a result of increased concern about the economy. The Government that was elected in May did not alter the tight economic and fiscal policies set by the previous Government, anticipating that these existing policies would improve the economy.

European Community

Denmark was expected to benefit from the European Community's (EC) drive for a single market, because eliminating the value-added tax was expected to enhance consumer spending in trade-dependent economies similar to that of Denmark. Concern was raised over Denmark's indirect taxes, which needed harmonizing to EC lev-

els. These taxes constitute 20% of total Government revenues. Direct foreign investment by other Nordic countries had greatly increased investment in recent years, to gain access to EC markets. Denmark's smaller size industries have exploited the export trade business and easily adapted to the technical requirements of other countries. These industries were thought to need structural realignment by internationalization to meet the challenges of the single EC Market.

Production and Trade

Production of North Sea oil and gas again increased significantly to record highs. Importation of most mineral fuels continued to decline. Imports of U.S. coal, however, more than doubled to \$71 million and increased in market share to 25% from the 10% share in 1987. Exports to the United States declined to \$1.1 billion or 5.7% of Danish exports. Imports from the United States increased 9%. The U.S. trade deficit with Denmark had been almost eliminated. Prospects were favorable for improving the U.S. trade balance with Denmark in 1989.

Danish exports of ferrous scrap increased 21% to a total of 222,000 tons and imports were down to 89,000 tons. The major trading partner for steel scrap was the Federal Republic of Germany. Some effort was made to keep steel scrap prices down to suppress the domestic demand and encourage exports.

Commodity Review

Industrial Minerals.—Cement.—A/S Aalborg Portland-Cement-Fabrik, Denmark's only cement producer, completed construction of its 4,000-ton-per-day, semidry, gray portland cement kiln at its Rordal plant in Aalborg. The new kiln, which replaced three smaller kilns, was operating at 4,700 tons per day by late summer. Aalborg, the world's largest producer, at 1.7 million tons, and exporter of white cement, indicated a 15% decline in total cement

production. Domestic demand for cement decreased because building construction declined. Exports of white cement remained strong despite foreign price competition; exports increased to a record high of 376,000 tons and were expected to improve further in 1989 with additional shipments to the United Kingdom. Aalborg, Denmark's largest industrial consumer of coal, initiated new energy-saving processes resulting in a 20% savings in production costs. The company continued to increase both its trucking and ocean fleets for shipping of bulk cement, coal, and fly ash. Aalborg's fleet transported 1.23 million tons of bulk cement to distant destinations such as the United States. A total of 450,000 tons of fly ash from Danish powerplants was transported to cement and concrete industries in Denmark and Norway.

Fertilizer Materials.—A statutory order was signed by the Danish environmental minister that limits the cadmium content in fertilizers. The order specified a limit of 200 milligrams of cadmium per kilogram of potassium in 1990. The cadmium content was to be lowered to 110 milligrams per kilograms of potassium in 1998. This lower limit agreement negotiated with the domestic fertilizer industry would affect even the low cadmium phosphates from South Africa, which represented 26% of the 1987 imports. Alternate imports from Morocco and the United States were postulated as replacement sources.

Mineral Fuels.—The major objective of Denmark's energy policy continued to be the reduction of net oil imports. This goal had been partially met by conversion of most electrical powerplants to coal, development of Danish North Sea oil and gas production, and energy conservation. The Government postponed the scheduled third round of licensing until 1989 and altered the terms of offshore licenses to boost interest in licensing during this period of

TABLE 1
DENMARK: SALES OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity		1984	1985	1986	1987 ^P	1988 [*]
Cement, hydraulic	thousand tons	1,668	1,739	2,029	1,887	1,600
Clays: ^a						
Kaolin		14,000	13,000	² 10,404	² 9,304	10,000
Other, for ceramic uses		² 4,168	² 4,686	6,000	6,000	6,000
Cryolite ³		20,300	17,900	18,000	17,200	18,000
Diatomaceous materials:						
Diatomite ^a		10,000	6,000	6,000	6,000	6,000
Moler		63,745	72,029	72,958	^a 66,000	66,000
Gas, natural ³	million cubic feet	8,228	38,811	67,274	85,700	90,000
Iron and steel: ³						
Steel, crude	thousand tons	548	528	632	606	² 650
Semimanufactures	do.	462	511	539	538	550
Lead, metal including alloys, secondary ⁴		13,019	4,503	^a 560	—	—
Lime, hydrated and quicklime	thousand tons	128	129	134	119	125
Peat	do.	32	39	48	^a 50	50
Petroleum: ³						
Crude	thousand 42-gallon barrels	17,700	22,120	27,700	35,200	40,000
Refinery products:						
Gasoline	do.	10,438	10,226	11,110	^a 11,100	11,100
Jet fuel	do.	681	1,017	1,525	^a 1,100	1,100
Kerosene	do.	429	125	172	^a 200	200
Distillate fuel oil	do.	23,162	22,326	24,723	^a 23,700	24,000
Residual fuel oil	do.	13,498	12,256	13,792	^a 15,500	16,000
Liquefied petroleum gas	do.	1,656	1,506	1,863	^a 2,000	2,000
Naphtha	do.	1,320	1,401	1,647	^a 1,800	1,800
Bitumen	do.	533	521	347	^a 400	400
Refinery fuel and losses	do.	3,020	2,880	3,322	^a 2,300	2,300
Total	do.	54,737	52,258	58,501	^a58,100	58,900
Salt ³	thousand tons	523	532	564	531	530
Sand, industrial	thousand cubic meters	1,026	1,368	1,629	^a 1,600	1,600
Sand and gravel ³	do.	23,200	24,600	28,500	32,100	32,000
Sodium carbonate	thousand tons	126	114	117	^a 120	120
Stone:						
Crushed:						
Flint	thousand cubic meters	47	54	59	^a 60	60
Limestone:						
Agricultural	thousand tons	2,163	1,882	1,972	^a 2,000	2,000
Industrial	do.	145	142	153	^a 150	150
Chalk	do.	220	203	249	^a 250	250
Other	thousand cubic meters	1,183	1,275	1,365	^a 1,400	1,400
Dimension (mostly granite)	do.	154	156	213	^a 200	200
Sulfur, byproduct		10,859	7,376	12,810	^a 13,000	13,000

^aEstimated. ^PPreliminary. ^rRevised.

¹Table includes data available through June 30, 1989.

²Reported figure.

³Data represent production.

⁴Includes antimonial lead.

low oil prices. The minimum share for the state company, Dopas, was reduced from 20% to 10%, which was similar to that of other North Sea countries. Royalties for new licenses in new areas were abolished. Adopting a United Kingdom practice of designating "linkage" areas to promote exploration, 94% of onshore and offshore areas were projected to be open for bids in 1989. All unlicensed areas also were included in the open bidding. In the Central Gtaben area, Dopas would continue 20% participation in projects producing up to 50,000 barrels per day; however, participation would increase to 40% for larger fields.

The emphasis to increase production from the Danish offshore resulted in an estimated 15% increase in oil production. However, the accumulated investment in North Sea petroleum development was approximately \$5 billion and had not yet been recovered from production. The recovery from the 1986 oil price collapse had made little corrective headway through most of 1988. The Finance Ministry indicated that full recovery of the investment was not expected by until the early 1990's, depending on world market prices for oil.

Coal.—Danish policy had been to import coal from several countries to provide source stability. Denmark, the largest Nordic consumer of coal, used more than 12 million tons providing 98% of domestically produced electricity. Three U.S. companies signed contracts to provide additional coal to Elsam, Denmark's largest utility group, and to Aalborg Cement Co. Australian coal had become the major source after the termination of the Republic of South Africa's one-quarter import share, however the devaluation of the dollar and the lower cost of shipment has benefited the U. S. industry. The landed price in Denmark of U.S. coal was approximately 40% above that of Australian coal during early 1987. Natural gas from the Norwegian North Sea poses the greatest competition to the

continued demand for coal to the Nordic area.

Natural Gas.—The Tyra Field in the Danish North Sea was the principal producer of Danish gas, which was piped to the mainland together with coproduct gas from Danish North Sea oil wells. Tyra also produced a significant quantity of condensate, roughly 1 million barrels per year, which was piped to the mainland via the Gorm Oilfield. The Government approved the development of Harald Field, previously known as Lulu and West Lulu. The projected \$780 million 18-slot well-head platform and 50 mile pipeline project was to access and deliver the 1.1 trillion cubic feet of reserves to the Government-owned gas distributor, Dansk Olie og Naturgas A/S (DONG). Two horizontal wells were approved by the Government for the Valdemar Field (Boje cluster) with tieback to Tyra East platform by a 13-mile, 8-inch pipeline. If the wells were found to be successful, four additional horizontal wells were possible for further development. Government approval was obtained for development by Dansk Undergrounds Consortium (DUC) of the Igor Gasfield, a satellite of the producing Dan Oilfield. However, the development schedule was not firm and was expected to be influenced by gas supply and demand. DONG began negotiations to procure more gas from domestic and Norwegian sources.

Petroleum.—Production of crude petroleum, all from the Danish North Sea, increased significantly as it had done each year since 1980. Construction of Dan-F, an extension of the Dan Field, was completed. Dan Field, operated by DUC was realizing a flow potential of 26,680 barrels per day in the first half of the year. DUC's 5,000 barrels per day enhancement program involved the drilling of horizontal wells from the complex. The exploration results from 16 wells drilled as offsets to Dan Field, however, were disappoint-

ing. Amoco's Raven Field to the north was still under evaluation. Amoco Denmark Exploration Company's small discovery in block 5504/1 made it the first non-DUC operator to find oil in the Danish sector. The overall Danish production exceeded 100,000 barrels per day for the first time. The estimated proven reserves were limited, but appeared to be sufficient to last until the end of the century.

DUC continued to control all significant gas and oilfield development and production in the Danish North Sea. The company consisted of the following company ownership: A.P. Moller (operator), 39%, Shell Olie og Gasudvinding Danmark BV, 46%, and Texaco A/S, 15%.

GREENLAND³

The Danish Government and Greenland Landsstyre signed an agreement to alter the principles of the Mineral Resources System for Greenland. The negotiations conducted by the Minister of Energy for the Danish Government and Greenland Home Rule Authorities agreed to equally share the first \$71 million in revenues from mineral exploitation and to negotiate any income in excess of that amount. The company, Nunaoil A/S, owned jointly by both parties was to promote the advancement of industrial development of mineral resources in Greenland.

The Geological Survey of Greenland continued its field explorations for minerals in southern Greenland and continued with a program initiated by the Governments of Denmark and Greenland to attract foreign firms to exploit mineral deposits in the area. The Geological Survey confirmed the existence of a large deposit of columbium and also discovered lanthanum-bearing deposits. Encouraging results were reported by Canadian firms exploring on Greenland in specific areas.

TABLE 2
GREENLAND: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity	1984	1985	1986	1987	1988 ^P
Cryolite, crude ore ²	67,200	111,500	70,343	38,185	—
Lead: Concentrate, Pb content	17,800	17,800	16,200	20,500	23,120
Silver: In lead concentrate, Ag content					
thousand troy ounces	334	276	385	418	418
Zinc: Concentrate, Zn content	71,300	70,300	62,100	69,200	77,520

^P Preliminary.

¹ Table includes data available through June 30, 1989.

² Shipments.

Commodity Review

Metals.—Boliden A/B continued ore extraction at Nunngarat, thereby assuring production of lead and zinc concentrates through 1989 at its Black Angel Mine. No significant exploration was conducted as the company concentrated on the enhancement recovery of the limited residuals during 1988.

Platinova Resources Ltd. is involved in two platinum prospects, and one is a joint venture with Boulder Gold N.L. of Sidney, Australia.

Industrial Minerals.—Platinova Resources Ltd., Highwood Resources Ltd., and Aber Resources Ltd. were developing a large deposit of zirconium, yttrium, and rare earths in an ice-free location near the southern tip of the island. Field work there consisted of diamond drilling to outline the reserve tonnage of the deposit. A bulk sample was shipped for pilot plant modeling.

Kryolitselskabet Oresund A/S shipped the last 15,000 tons of high-grade cryolite from a pit at Ivigtut. This last shipment of crude ore to Denmark marked the end of 131 years continuous mining activity at the pit. The company allowed the seawater to fill the pit containing 1.5 million of low grade reserves remaining, containing 12% cryolite and 20% fluorite. During 1988, deep drilling by Kryolitselskabet Oresund A/S inter-

sected a cryolite-bearing granite similar to that which had been mined at Ivigtut. However, the company's position was that further mining was not viable because of the low mineral contents of the available ores. The prospecting and data material from Kryolitselskabet's archives were transferred to Greenland Geological Inspectorate.

A/S Carl Nielson completed a 2-year field and laboratory project on zircon and rare earths in southwest Greenland. Three million tons of eudialyte in four separate bodies were defined with a grade of 4% yttrium and from 2% to 3.5% ZrO₂. Bulk samples were taken to Denmark for pilot plant modeling; the eudialyte is the raw material used in an EC Euram project. This project was undertaken by several Danish groups to study the alternatives to yttrium stabilization of ceramic zirconia powders. Other research and development projects by Carl Nielson included a high-grade silica sand deposit for possible use by the glass industry. A mining concession had been granted for this project. A total of eight exploration concessions and three prospecting licenses were granted in 1988.

Mineral Fuels.—Reconnaissance seismic work was completed on the Ice Sheet by a consortium operated by A/S Arco Greenland. Deep drilling was postponed until 1990.

FINLAND⁴

The Finnish minerals industry and related manufacturing sectors continued to do well in 1988. The country continued to be a significant producer of mineral products including chromite ore, ferrochrome and stainless steel, industrial minerals, nickel and zinc. In particular, nickel concentrate production rose over 20%, mainly because of the presence of new mines. Chromite concentrate also showed an increase because of greater demand.

Finland's economy was out of equilibrium, and output growth was increasing based on domestic demand. This led to a strong import growth and diverted resources from the export sector, which operated near or at capacity during 1988. Real GDP increased 4.8% compared with 3.6% in 1987. Inflation rose to 5% for 1988 with a 4.5% unemployment rate.

The Mining Division of Outokumpu Oy was divided into two parts at the beginning of 1988. The domestic mining and exploration operations, along with those in Norway and Sweden, were combined to form the Nordic Mining Group (NMG), and foreign operations outside Finland, Norway, and Sweden were placed under the name Outokumpu Resources Inc. (ORI) with headquarters in London, England. Outokumpu ceased in-house field op-

erations involving drilling, sampling, and geophysics. In the future these functions will be contracted out to other companies.

The Outokumpu Group, the largest mining and metallurgical company in Finland, had 80 subsidiaries in over 20 countries. Nearly 90% of Outokumpu Group sales were outside Finland, and one-third of Outokumpu's 15,000 employees worked abroad. The majority state-owned company was listed on the Helsinki stock exchange in October 1988.

In 1988, Outokumpu, together with other international companies, made a preliminary agreement to open the La Escondida Mine in Chile. Outokumpu would not be a shareholder in the mine, however, it was obligated to put approximately \$50 million⁵ toward the mine's startup costs. The credit was provided by KOP-BANK, and guaranteed by the Finnish Export Credit Co. The Transportation Workers Union of Finland threatened Outokumpu with a boycott of copper concentrate shipments if the political situation in Chile did not show improvement. Negotiations were continuing at yearend.

In 1988, Finland became a consultative party to the Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA) Antarctic Agreement allowing the country to take part in antarctic mineral exploitation beginning in 1989.

The small size and openness of the Finnish economy means that international economic conditions have a greater impact on activities, such as mining, than do domestic factors. The increase in world market prices for basic metals was an incentive to reopen Finnish mines that were considered unprofitable earlier. Prospecting was also more attractive. Dwindling domestic reserves have forced the industry to look abroad, and to develop new, more effective production methods to remain competitive.

Production and Trade

The Finnish mining industry is dominated by two state-owned companies,

Outokumpu and Kemira Oy. These companies, mines produced nearly one-half of the ore extracted in Finland. Oy Partek AB, privately owned, was the major Finnish limestone producer. Outokumpu specialized in base metals, and Kemira specialized in fertilizer and agriculture chemicals and operated the Siilinjärvi apatite mine. This mine was the only phosphate mine in Western Europe, and supplied the concentrate for Finnish fertilizer consumption.

Total ore excavated in Finland rose almost 5% compared with 1987. The production of metallic ores amounted to 6.1 million tons, same as 1987. Eight metal mines were in operation at the beginning of 1988; however, this number was reduced with the closure of the Rautuvaara and Hannukainen iron ore operations of Rautaruukki Oy. This signaled the end of iron ore mining in Finland. Three new mines were started in late 1988, which made a total of nine metal mines operating at yearend.

In 1988, there were 30 mines operating in the industrial mineral sector that produced almost 14 million tons of industrial minerals as compared with almost 13 million tons in 1987. These included apatite, feldspar, limestone, talc, quartz, and wollastonite.

About 35% of Finland's exports were direct products of the metallurgical, mining equipment, and machinery industries. Raw material imports included 80% of the iron concentrates, 75% of the copper concentrates, 70% of the zinc concentrates, and 50% of the nickel matte and concentrate needed to support the country's industries. Finland continued to be dependent on imports, mostly crude oil from the U.S.S.R., for about two-thirds of its energy supply.

Commodity Review

Metals.—Chromium.—Western Europe's only chromite mine was Outokumpu's Kemi Mine. The mine, together with a ferrochrome plant at Tornio, was a part of Outokumpu's Stainless Steel Division With estimated

reserves of 150 million tons, Kemi ranked as one of the world's major chromite mines and provided a sound resource base for the Stainless Steel Division. In late 1988, Outokumpu announced it would expand ferrochrome production by 30%, to about 180,000 tons per year. The plan was to modernize the pelletizing and sintering plant of the Tornio Works and to increase capacity of the Kemi Mine. The Kemi Mine annually excavated about 1 million tons of chromite ore, which contained an average 26% chromium dioxide. The expansion was estimated to cost \$20 million, and the new facilities were scheduled to be on-stream by 1990. The company intended to use all its production and to cease outside sales of unprocessed ore from the mine.

Copper.—Outokumpu completed another stage of its ongoing corporate reorganization plan in 1988 by placing all of its copper operations into a new independent company to become effective January 1, 1989. The company was to be named Outokumpu Copper Oy and be headquartered in Espoo, Finland.

The metallurgical plants, including the Pori Works copper refinery and fabrication facility, would become a wholly owned subsidiary of Outokumpu Copper and would operate under the new name of Poricopper Oy.

The new company would also include the overseas copper operations, such as the Metallverken Group of Sweden, Nippert Co. and Valleycast Inc. of the United States, a 21% minority holding in Iberica del Cobre de Spain, as well as marketing organizations in Belgium, the Federal Republic of Germany, Spain, Switzerland, and the United States.

Gold.—Outokumpu announced it would start operations at its first gold mine in Finland at the beginning of 1989. Overburden and waste have been stripped from the ore body. The Saattopora open pit mine is at Kittilä in Finnish Lapland. Reserves were esti-

TABLE 3
FINLAND: PRODUCTION OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity		1984	1985	1986	1987	1988 ^P
METALS						
Aluminum metal, secondary		17,100	21,000	22,200	25,700	29,900
Cadmium metal, refined		614	565	'523	687	703
Chromium: Chromite:						
Gross weight:						
Lump ore ^o	thousand tons	312	327	450	338	450
Concentrate	do.	119	167	'203	192	235
Foundry sand ^o	do.	15	12	'15	13	15
Total	do.	446	506	678	543	700
Cr ₂ O ₃ content:						
Lump ore ^o	do.	² 84	88	95	91	95
Concentrate	do.	47	67	^o 75	^o 77	85
Foundry sand ^o	do.	² 7	6	5	6	10
Total	do.	138	161	^o175	^o174	190
Cobalt:						
Mine output, Co content		860	'1,092	627	190	200
Metal, refined		1,453	'2,230	1,348	497	220
Copper:						
Mine output, Cu content		30,834	27,897	25,987	20,398	20,200
Metal:						
Smelter		77,600	68,900	84,460	77,400	79,000
Refined		57,318	58,766	64,235	59,500	53,900
Gold metal	troy ounces	28,067	19,130	37,680	^o 58,000	65,425
Iron and steel:						
Iron ore, marketable, all types: ³						
Gross weight	thousand tons	1,231	1,122	973	896	^o 556
Fe content	do.	806	738	635	588	^o 360
Metal:						
Pig iron	do.	2,044	1,891	1,978	2,063	2,174
Ferroalloys, ferrochromium	do.	59	133	134	143	156
Steel, crude	do.	2,632	2,518	2,586	2,669	2,798
Semimanufactures, rolled	do.	1,985	2,063	1,997	2,025	2,300
Lead:						
Mine output, Pb content		2,478	2,422	1,980	^o 2,400	1,900
Refined, secondary		^o 4,500	4,600	1,200	^o 1,200	^o 2,000
Mercury	76-pound flasks	2,292	3,630	4,239	4,178	3,770
Molybdenum metal		(⁴)	(⁴)	(⁴)	(⁴)	—
Nickel:						
Mine output, Ni content		6,918	8,547	11,886	10,557	^o 11,699
Metal, electrolytic		15,282	15,656	17,791	15,392	15,721

See footnotes at end of table

TABLE 3—Continued

FINLAND: PRODUCTION OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity		1984	1985	1986	1987	1988 ^P
METALS—Continued						
Platinum-group metals:						
Palladium	troy ounces	1,093	1,125	3,086	*3,100	3,407
Platinum	do.	1,061	1,125	3,858	*3,900	1,736
Selenium metal	kilograms	16,975	14,038	5,693	*10,000	28,935
Silver metal	thousand troy ounces	1,123	998	1,193	1,421	1,010
Vanadium: Mine output, V ₂ O ₅ content		5,469	3,805	—	—	—
Zinc:						
Mine output, Zn content		60,200	60,606	60,351	55,100	63,900
Metal		158,819	160,377	155,397	151,500	156,000
INDUSTRIAL MINERALS						
Barite		8,704	8,690	6,969	11,000	11,000
Cement, hydraulic	thousand tons	1,645	1,608	1,422	1,426	1,504
Feldspar		56,265	52,940	47,049	52,000	50,000
Mica, flake		—	—	—	*5,000	*5,000
Lime	thousand tons	241	252	261	271	260
Nitrogen: N content of ammonia		68,700	65,100	66,800	50,300	43,000
Phosphate rock, apatite concentrate:						
Gross weight	thousand tons	477	512	527	553	584
P ₂ O ₅ content	do.	176	178	185	195	215
Pyrite, gross weight	do.	426	493	547	621	615
Sodium sulfate ^a	do.	35	35	35	35	*35
Stone, crushed:						
Limestone and dolomite:						
For cement manufacture	do.	2,287	2,217	1,968	*1,750	2,150
For agriculture	do.	1,192	1,453	1,108	*1,050	1,107
For lime manufacture	do.	367	357	381	*330	420
Fine powders	do.	316	313	330	*290	330
Metallurgical	do.	45	26	13	*12	123
Total	do.	4,207	4,366	*3,800	*3,432	4,130
Quartz silica sand	do.	262	223	232	233	272
Sulfur:						
S content of pyrite	do.	214	248	276	313	300
Byproduct:						
Of metallurgy	do.	265	257	260	*230	240
Of petroleum	do.	45	*45	42	*40	47
Total	do.	524	550	578	*583	587
Sulfuric acid	do.	1,165	1,462	1,359	1,160	1,095
Talc	do.	327	319	284	319	379
Titania concentrate: ilmenite:						
Gross weight	do.	167	53	—	—	—
TiO ₂ content	do.	75	24	—	—	—

See footnotes at end of table.

TABLE 3—Continued
FINLAND: PRODUCTION OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1984	1985	1986	1987	1988 ²
INDUSTRIAL MINERALS—Continued					
Wollastonite	14,669	16,917	15,795	25,000	28,000
MINERALS FUELS AND RELATED MATERIALS					
Peat:					
For fuel use thousand tons	2,713	3,140	*3,600	*2,100	*32,000
For agriculture and other uses do.	246	346	*400	*350	*350
Petroleum refinery products thousand 42-gallon barrels	73,500	72,500	65,300	73,400	72,000

* Estimated. ² Preliminary. ³ Revised.

¹ Table includes data available through May 1, 1989.

² Reported figure.

³ Includes approximately 30% of unused roasted pyrite (purple ore) from the Kokkola Works.

⁴ Revised to zero.

mated to be 700,000 tons of ore grading 0.1 ounce of gold per ton and 0.3% copper. Mining was expected to last for at least 2 years.

The ore zones averaged 10 meters in thickness and had a dip of about 50°. The deposit was hosted by albite felsite rocks, with an ultrabasic or albite foot wall, and the hanging wall is formed by tuffites. The final open pit was expected to be 300 meters long by 150 meters in width and 70 meters deep.

The ore would be trucked 34 miles to the Rautuvaara concentrator that was purchased by Outokumpu in late 1988 from Rautaruukki Oy. Outokumpu had modified the concentrator to treat the Saattopora ore, and was expected to achieve a 90% gold recovery.

Iron and Steel.—Rautaruukki terminated its unprofitable mining operations at the end of 1988 by closing its last mine, the Rautuvaara Iron and Copper Mine. The company had closed its Hannukainen Mine earlier in the year. Rautaruukki was no longer involved in ore prospecting except for international coal exploration for its steel factories. At yearend, iron ore was no longer mined in Finland. However, there may be a new future for mining in

the Kolari area. An iron ore deposit containing rare metals had been discovered about 40 kilometers south of the closed Rautuvaara Mine. The deposit was large, and the iron ore contained titanium and vanadium. There was considerable interest in the deposit because ore containing this combination of metals had not been found previously in Finland. Exploration was continuing at yearend.

Ovako Steel Oy AB revamped its secondary steelmaking and casting facilities at the scrap-based Imatra Steelworks. The equipment, which was commissioned in late 1988, included a ladle furnace, injection station, vacuum degasser, a bloom continuous caster, and a reheating furnace for the blooms. The estimated cost of the project was \$120 million. This investment was expected to rationalize production and increase product quality. There was the possibility of raising production from 260,000 tons of crude steel and 200,000 tons of rolled products per year to 310,000 tons of steel, 210,000 tons of rolled products, and 45,000 tons of billets per year.

Outokumpu commissioned its new 500,000-ton-per-year hot strip stainless steel mill at the Tornio Works in early

1988. The company invested \$170 million in the project. Outokumpu was considered to be the world's only stainless steelmaker to possess a complete integrated production line from chromite ore to finished steel at one site. The main reasons for building a hot-rolling mill for the Tornio Works were technical considerations, savings in transport charges, shorter throughput times, and ability to develop new grades of products.

Nickel.—In mid-1988, Outokumpu reopened the Hitura Mine, which had been closed since 1985. The mine has estimated nickel ore reserves of 600,000 tons. Production could be 3,000 to 4,000 tons per year of nickel concentrate. The Halvalia Mine restarted operations and the new underground nickel mine at Telkkala in 1988. Reserves at Telkkala were estimated at 350,000 tons grading 2% nickel and 0.6% copper. The startup of these mines resulted in a rise in nickel concentrate production of over 20%. The mines that were started up were all relatively small and were expected to be in production for 2 to 3 years. In February 1988, an oxygen plant explosion in Outokumpu's Harjavalta facil-

ities put both a 50-ton-per-day nickel cathode smelter and a 300-ton-per-day copper anode smelter out of operation. The copper smelter was restarted using another oxygen plant; however, it was mid-1988 before production resumed at the nickel smelter. The plant was operating at approximately 60% capacity until a new oxygen plant could be constructed. Production losses were estimated at 650 tons of catalytic nickel. Although the quantity of nickel involved is not substantial in terms of total world nickel production, the Outokumpu nickel is a high-quality plating-grade nickel and significantly affected that segment of the market.

Other Metals.—Kajaani Oy continued exploration efforts on a silver deposit at Taivaljarvi in Soikamo. The company was constructing a 350-meter-deep shaft to acquire more information. Taivaljarvi was the most promising silver deposit in Finland with an estimated 10 million tons of ore, 4 million tons of which contain over 3 ounces of silver per ton. At 1988 silver prices, the deposit would not be profitable; however, Kajaani had begun negotiations with Outokumpu to jointly exploit the deposit. Taivaljarvi also contained varying minor amounts of gold, lead, and zinc.

Outokumpu reported the discovery of a zinc ore body near its Pijhasalmi Mine. The deposit assayed around 8% to 10% zinc content; however, the deposit appeared to be small. Investigation was continuing at yearend. The company was also undertaking a pilot stopping operation on a small platinum-palladium deposit in the north of the country and was developing a recovery program to process the ore.

Industrial Minerals.—**Phosphate Rock.** Kemira, the Lapponia Province, and the Northern Finland Research Center of the University of Oulu were investigating the profitability of the Sokli phosphate

deposit in Lapland. Kemira estimated that 1.8 million tons of phosphorus concentrates per year could be produced from the Sokli Mine, which would give the mine a 20- to 25-year life expectancy. Annually, the Sokli Mine would produce three times as much phosphorus concentrate as Kemira's Siilinjärvi Mine, the largest phosphate rock mine in Finland. Since Siilinjärvi already produced more than Finland's domestic needs could accommodate, all of the Sokli Mine's production was expected to be exported. For reasons of cost, Kemira would not refine the phosphorus concentrate in Finland. Instead, the concentrate would be shipped via pipeline to Kemi and from there to Kemira's fertilizer factories in Belgium, Denmark, and Holland.

Other Industrial Minerals.—The Geologic Survey of Finland was prospecting for industrial minerals, especially lime, granite, and kaolin. A promising deposit of mica and one of granite was discovered in Vammala. The granite was of uniform quality but the extent of the deposit was unknown. In addition, a kaolin deposit in Virtsalmi was being investigated. The kaolin deposit was a significant one with several million tons of high kaolin content material.

Partek Oy, a major limestone producer in Finland, bought Myllykoski Oy's talc operation in Luikonlahti. The operation consisted of a talc factory and three talc quarries. The output amounted to around 75,000 tons annually and consisted mainly of talc products for the paper and paperboard industries.

Partek was part of a Nordic joint venture to build a lime kiln for reactive burnt lime production on Sweden's Gotland Island. Partek owned one-half of the Swedish limestone mine, which has an annual production of 2 million tons. The company entered into a cooperative agreement with the U.S.S.R. on industrial minerals development and also participated in a project for increasing the level of wollastonite refinement.

Other activities included the prospecting by Lohja Oy for industrial minerals; Partek, for lime and kaolin; Malmikaivos Oy, for pigments; Ruskealan Marmori, for lime; and Finn Metals for talc.

Mineral Fuels.—Finland was one of the world's highest per capita energy consumers due to its harsh climate and industrial infrastructure. In 1988, primary energy consumption totaled 29.7 million tons oil equivalent up 1.4% from the previous year. Use of oil as primary energy fell by 2% to 9.5 million tons oil equivalent. Oil was being replaced by nuclear- and coal-produced electricity.

In 1988, natural gas imports, all from the U.S.S.R. via pipeline, totaled 1.7 billion cubic meters, 7% more than 1987. All the natural gas imported from the U.S.S.R. is fed into Finnish pipelines from a compressor station north of Leningrad. The 700-kilometer-long pipeline network extends from the Soviet border inland to the cities of Tampere, Lahti, and Helsinki in Finland.

In 1988, the U.S.S.R. was constructing a parallel natural gas pipeline between Leningrad and the West Siberian deposits, and increasing storage facilities for natural gas. These projects were related to plans to transport Soviet natural gas to Sweden via southern Finland. Sweden was to decide in 1989 whether or not to buy Soviet natural gas. Regardless of the Swedish decision, Finland was planning to extend the pipeline network to the Finnish west coast at Turku.

Finland had no indigenous supply of hydrocarbon fuels other than peat. Around 10% of indigenous energy came from peat, and in 1988, peat supplied 3% of primary energy.

ICELAND⁶

Positive changes occurred in Iceland's metals and mineral industry in

1988. Primary aluminum, ferrosilicon, and cement production increased over 1987 levels. These industries constituted over 90% of the value of total mineral production. The improvement in the world markets for aluminum and ferrosilicon encouraged those plants in Iceland to expand output and, for the first time in years, to make a profit on their operations.

There was strong economic growth in 1987. The GDP increased by over 6% in real terms, but was expected to decline by 1% with little or no growth in 1988. This was mainly the result of lower fish catches combined with lower world prices for fish. The rate of inflation doubled from 13% in 1986 to almost 26% in 1988. Iceland's unit of currency, the krona, underwent three devaluations in 1988.

Iceland's main mineral industries were aluminum and ferrosilicon, and both were highly energy intensive. Iceland has installed hydroelectric power capacity of 4,200 gigawatt hours per year. The aluminum and ferrosilicon producers are the major users of this economical source of energy. To maintain the desired flexibility to respond to different energy demand developments required by energy-intensive industrialization, Landsvirkjun, the national power company, was constructing the 150-megawatt Blanda hydropower project, which was expected to be operational in 1991. The increasing energy demand of the present market will be met by this plant, and the Government will also be in a position to offer favorable rates to new energy-intensive customers.

Production and Trade

Production of aluminum and ferrosilicon increased. Sales and production by Sementsverksmidja Ríkisins, the state cement factory, set a new record while there was a 5% drop in sales by Aburdaverksmidja Ríkisins, the state fertilizer factory. Production of diatomite increased at Kisilidjan Corp. mines near Krafla, with a 15% increase in export sales. The trade deficit was expected to reach around \$130 million.⁷ This, combined with payment of interest on foreign loans, was expected to leave a 1988 balance-of-payments deficit of \$250 million.

Commodity Review

Production of primary aluminum at Icelandic Aluminum (ISAL) increased

TABLE 4
ICELAND: PRODUCTION OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1984	1985	1986	1987	1988 ^P
Aluminum metal, primary ²	80,359	73,403	75,929	83,485	82,034
Cement, hydraulic ² thousand tons	118	114	111	127	134
Diatomite	27,265	29,388	22,897	22,897	25,142
Iron and steel: Ferrosilicon	60,976	60,328	66,787	60,184	70,051
Nitrogen: N content of ammonia	*7,000	7,532	7,980	9,039	8,812
Pumice and related volcanic material:					
Pumice	55,000	56,000	52,500	58,792	65,444
Scoria	*675	*375	*375	271	351
Salt	950	1,350	704	1,830	*2,000
Sand:					
Basaltic cubic meters	4,000	5,500	*5,000	5,400	2,300
Calcareous, shell thousand cubic meters	115	100	129	115	135
Sand and gravel do.	4,700	4,150	4,088	4,316	*4,200
Silica dust ⁴	³ 7,221	³ 7,873	13,886	12,131	*10,000
Stone, crushed:					
Basaltic thousand tons	90	80	77	114	91
Rhyolite	20,000	25,755	23,114	22,700	28,300

^P Estimated. ^P Preliminary. ^R Revised.

¹ Table includes data available through May 31, 1989.

² Ingot and rolling billet production.

³ Sales.

⁴ Byproduct of ferrosilicon.

TABLE 5
ICELAND: EXPORTS OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity	1986	1987	Destinations, 1987	
			United States	Other (principal)
Abrasives, n.e.s: Natural: Corundum, emery, pumice, etc.	36,939	58,771	334	United Kingdom 20,161; Norway 17,499; West Germany 10,734.
Aluminum:				
Ash and residue containing aluminum	—	14	—	All to Netherlands.
Metal including alloys, unwrought	77,490	89,081	—	West Germany 28,339; Switzerland 22,275; United Kingdom 18,626.
Diatomite and other infusorial earths	23,423	23,214	—	West Germany 6,689; Italy 2,901; United Kingdom 2,194.
Fertilizer materials, manufactured:				
Nitrogenous	—	4	—	All to West Germany.
Unspecified and mixed	—	9	—	All to Sweden.
Iron and steel: Metal:				
Scrap	2,527	7,668	—	Spain 5,100; Netherlands 2,566.
Ferrosilicon	64,990	71,656	20,410	Japan 31,089; West Germany 9,733.
Stone, sand and gravel: Dimension stone, crude and partly worked	591	271	—	West Germany 161; Denmark 91; Netherlands 19.
Other: Base metals including alloys, scrap	635	845	—	Netherlands 716; Denmark 64; West Germany 36.

¹ Table prepared by P. J. Roetzel.

with a pretax profit of about \$11 million expected. This was the best performance in the 22-year-old company's history. High prices for aluminum on the world market were the main reason for the record profit. As a result of the high market price, ISAL was paying the maximum price of 18.5 mills (\$0.0185) per kilowatt hour for electricity. This raised Landsvirkjun's earnings to more than \$20 million.

In 1988, four European aluminum companies agreed to conduct a feasibility study for another aluminum smelter at Straumsvik, south of Reykjavik, near

the plant already operated by ISAL. The \$500,000 study, contracted out to the Bechtel Co. of the United States, was funded by Alumined Beheer of the Netherlands, Austria Metal of Austria, Granges of Sweden, and Alusuisse, the parent company of ISAL. The study focused on the feasibility of constructing a 90,000- to 110,000-ton-per-year aluminum smelter to go on-line in 1992. This would double Iceland's existing production, which already brought in around one-sixth of export earnings.

Several other foreign firms, including Norsk Hydro A/S, Norway; Alu-

max, United States; and Essenbau, Federal Republic of Germany, have contacted the Government in regards to possible construction of a third aluminum smelter.

Icelandic Alloys—owned by the Government of Iceland (55%), Elkem A/S of Norway (30%), and Sumitomo Corp. of Japan (15%)—produced an unexpectedly high profit in 1988. High market prices and rising demand contributed to this. Modifications, which have boosted plant capacity 20%, were also attributed to the upturn in performance.

TABLE 6
ICELAND: IMPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity		1986	1987	Sources, 1987	
				United States	Other (principal)
METALS					
Aluminum:					
Ore and concentrate	kilograms	—	100	—	All from United Kingdom.
Oxides and hydroxides		138,028	142,335	(²)	Australia 142,327; West Germany 8.
Metal including alloys:					
Scrap		1	—	—	
Unwrought		87	29	—	Mainly from United Kingdom.
Semimanufactures		1,197	1,442	33	Norway 314; Belgium-Luxembourg 270; West Germany 240.
Beryllium: Metal including alloys, all forms					
		(²)	—	—	
Chromium: Oxides and hydroxides	kilograms	2,000	500	—	Mainly from West Germany.
Cobalt: Oxides and hydroxides	value, thousands	(²)	\$1	—	All from Sweden.
Columbium and tantalum: Metal including alloys, all forms: Tantalum					
		(²)	—	—	
Copper:					
Ore and concentrate		120	60	—	All from West Germany.
Metal including alloys:					
Unwrought		5	4	—	Mainly from Denmark.
Semimanufactures		218	218	12	West Germany 82; Sweden 56; United Kingdom 16.
Gold: Metal including alloys, unwrought and partly wrought					
	value, thousands	\$126	\$174	\$36	Switzerland \$31; Netherlands \$30; Republic of South Africa \$23.
Iron and steel:					
Iron ore and concentrate excluding roasted pyrite		24,862	17,162	—	Norway 17,144; United Kingdom 18.
Metal:					
Pig iron, cast iron, related materials		327	381	17	Netherlands 303; United Kingdom 30.
Ferrous alloys:					
Ferromanganese	kilograms	—	300	—	All from Norway.
Ferrosilicon	do.	—	300	—	Do.
Unspecified		6	9	—	U.S.S.R. 8; Sweden 1.
Steel, primary forms		641	1,236	—	Sweden 737; Netherlands 335; Czechoslovakia 98.
Semimanufactures:					
Bars, rods, angles, shapes, sections		18,952	23,663	4	Norway 7,642; Poland 4,519; Spain 2,480.
Universals, plates, sheets		12,863	14,889	1	Belgium-Luxembourg 2,981; West Germany 2,847; Norway 2,427.
Hoop and strip		579	1,085	23	Czechoslovakia 292; Norway 225; Belgium-Luxembourg 186.
Rails and accessories		68	13	—	West Germany 7; Italy 3; Denmark 2.
Wire		290	321	(²)	Belgium-Luxembourg 188; Denmark 29; Finland 25.
Tubes, pipes, fittings		7,506	6,622	157	Netherlands 1,909; West Germany 1,854; Czechoslovakia 649.

See footnotes at end of table.

TABLE 6—Continued
ICELAND: IMPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1986	1987	Sources, 1987	
			United States	Other (principal)
METALS—Continued				
Iron and steel—Continued				
Metal—Continued				
Semimanufactures—Continued				
Castings and forgings, rough	156	280	—	Norway 142; Denmark 46; West Germany 40.
Lead:				
Oxides	16	13	—	West Germany 8; Sweden 2.
Metal including alloys:				
Scrap	—	10	—	All from Denmark.
Unwrought	246	297	—	United Kingdom 204; Denmark 66; Sweden 18.
Semimanufactures	30	56	(²)	West Germany 41; Belgium-Luxembourg 11; Denmark 4.
Magnesium: Metal including alloys:				
Unwrought	127	30	—	All from Norway.
Semimanufactures kilograms	(³)	300	—	All from West Germany.
Manganese: Oxides	4	6	—	Mainly from Netherlands.
Mercury 76-pound flasks	3	3	—	Mainly from Norway.
Nickel: Metal including alloys, semimanufactures	3	2	—	United Kingdom 1.
Platinum-group metals: Metals including alloys, unwrought and partly wrought value, thousands	\$141	\$181	\$5	Switzerland \$89; Netherlands \$53; West Germany \$25.
Silver: Metal including alloys, unwrought and partly wrought do.	\$89	\$156	\$16	Sweden \$45; Denmark \$26; Switzerland \$26.
Tin: Metal including alloys:				
Scrap	4	1	—	All from Belgium-Luxembourg.
Unwrought	1	(²)	—	All from United Kingdom.
Semimanufactures	9	5	(²)	Denmark 3; United Kingdom 1.
Titanium: Oxides	505	484	—	United Kingdom 316; Norway 85; West Germany 80.
Tungsten: Metal including alloys, all forms value, thousands	\$12	\$4	\$3	United Kingdom \$1.
Zinc:				
Oxides	11	10	—	West Germany 8; Norway 2.
Blue powder	12	14	—	Denmark 7; Norway 4; United Kingdom 3.
Metal including alloys:				
Scrap	—	3	—	All from Belgium-Luxembourg.
Unwrought	71	92	—	Norway 39; West Germany 36; Belgium-Luxembourg 15.
Semimanufactures	29	11	(²)	France 10.
Other: Base metals including alloys, all forms	13	2	—	West Germany 1.

See footnotes at end of table.

TABLE 6—Continued
ICELAND: IMPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1986	1987	Sources, 1987		
			United States	Other (principal)	
INDUSTRIAL MINERALS					
Abrasives, n.e.s.:					
Natural: Corundum, emery, pumice, etc.	34	98	11	Netherlands 51; Italy 25.	
Artificial: Corundum	(^a)	1	—	All from Denmark.	
Grinding and polishing wheels and stones	34	40	(^a)	West Germany 8; Italy 5; Sweden 5.	
Barite and witherite	38	32	—	West Germany 20; Denmark 11.	
Boron materials:					
Crude natural borates	10	—			
Oxides and acids kilograms	400	500	—	Mainly from West Germany.	
Cement	181	158	2	Denmark 52; Belgium-Luxembourg 36; Sweden 36.	
Chalk	290	290	—	United Kingdom 95; Norway 81; France 62.	
Clays, crude	327	511	127	United Kingdom 315; Netherlands 42.	
Cryolite and chiolite	50	—			
Diamond, natural:					
Gem, not set or strung value, thousands	\$55	\$84	—	Belgium-Luxembourg \$59; Netherlands \$8; Switzerland \$7.	
Industrial stones do.	\$10	\$12	—	Denmark \$6; Belgium-Luxembourg \$5.	
Diatomite and other infusorial earth	62	2	(^a)	France 1; Netherlands 1.	
Feldspar, fluorspar, related materials kilograms	200	300	NA	NA.	
Fertilizer materials: Manufactured:					
Ammonia	7,336	5,071	—	France 3,982; Norway 1,047.	
Nitrogenous	146	667	2	West Germany 550; Norway 86; Denmark 24.	
Phosphatic	1,263	1,535	—	All from Sweden.	
Potassic	9,871	9,162	—	East Germany 8,412; Austria 750.	
Unspecified and mixed	13,171	9,076	2	Morocco 5,778; Netherlands 2,845; West Germany 362.	
Graphite, natural	18	15	—	Mainly from United Kingdom.	
Gypsum and plaster	4,555	6,684	—	Sweden 6,642; Denmark 17.	
Lime	510	512	—	United Kingdom 266; West Germany 224; Denmark 20.	
Magnesite, crude	2	13	—	Mainly from Netherlands.	
Mica:					
Crude including splittings and waste	30	16	—	Norway 15.	
Worked including agglomerated splittings kilograms	100	100	—	Mainly from Switzerland.	
Nitrates, crude	—	88	—	Norway 76; Denmark 12.	
Phosphates, crude	12	16	—	Denmark 11.	
Pigments, mineral: Iron oxides and hydroxides, processed	41	49	—	Denmark 20; West Germany 10; Spain 8.	

See footnotes at end of table.

TABLE 6—Continued
ICELAND: IMPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity		1986	1987	United States	Sources, 1987
					Other (principal)
INDUSTRIAL MINERALS—Continued					
Precious and semiprecious stones other than diamond:					
Natural	value, thousands	\$19	\$12	—	West Germany \$4; United Kingdom \$2; Norway \$1.
Synthetic	do.	\$14	\$14	—	West Germany \$6; Belgium-Luxembourg \$5.
Salt and brine		83,525	103,442	1	Spain 97,590; West Germany 3,455; United Kingdom 804.
Sodium compounds, n.e.s.:					
Carbonate, manufactured		1,493	1,189	—	France 775; United Kingdom 151; West Germany 110.
Sulfate, manufactured		126	120	(²)	Sweden 89; Denmark 19; West Germany 10.
Stone, sand and gravel:					
Dimension stone:					
Crude and partly worked		213	217	—	China 84; Norway 61; Italy 31.
Worked		545	1,093	—	Italy 578; Portugal 455; Denmark 21.
Dolomite, chiefly refractory-grade		344	957	—	Norway 928; Sweden 24.
Gravel and crushed rock		202	12,419	—	Norway 12,247; Italy 60.
Limestone other than dimension		155	151	—	Denmark 146; Sweden 5.
Quartz and quartzite		135,506	87,347	63	Spain 46,750; Norway 40,475.
Sand other than metal-bearing		264	372	(²)	Netherlands 95; Sweden 90; Denmark 81.
Sulfur:					
Elemental:					
Crude including native and byproduct		38	(⁴)	(⁴)	
Colloidal, precipitated, sublimed		1	3	—	Belgium-Luxembourg 2.
Dioxide		10	—		
Sulfuric acid		95	78	—	Denmark 65; Netherlands 7; West Germany 2.
Talc, steatite, soapstone, pyrophyllite		95	89	2	Norway 79; Sweden 2.
Other:					
Crude		1	75	—	Finland 29; Norway 24; Sweden 21.
Slag and dross, not metal-bearing		171	333	—	Norway 300; Netherlands 30.
MINERAL FUELS AND RELATED MATERIALS					
Asphalt and bitumen, natural		63	29	—	Belgium-Luxembourg 19; United Kingdom 5; Denmark 4.
Carbon black	kilograms	300	300	—	NA.
Coal:					
Anthracite		49,898	40,409	40,379	United Kingdom 30.
Bituminous		23,622	19,510	19,508	Denmark 2.
Briquets of anthracite and bituminous coal		—	22	12	Norway 10.

See footnotes at end of table.

TABLE 6—Continued
ICELAND: IMPORTS OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity	1986	1987	Sources, 1987		
			United States	Other (principal)	
MINERAL FUELS AND RELATED MATERIALS—Continued					
Coal—Continued					
Lignite including briquets	1,945	5	—	All from United Kingdom.	
Coke and semicoke	39,602	31,977	—	Norway 25,726; East Germany 5,072; United Kingdom 1,106.	
Peat including briquets and litter	192	238	—	Finland 113; Sweden 77; Netherlands 30.	
Petroleum refinery products:					
Liquefied petroleum gas	thousand 42-gallon barrels	11	11	(^a) Sweden 4; Norway 3; Denmark 2.	
Gasoline	do.	1,026	1,023	— U.S.S.R. 697; Netherlands 265; Belgium-Luxembourg 60.	
Mineral jelly and wax	do.	3	3	(^a) United Kingdom 2.	
Kerosene and jet fuel	do.	495	806	(^a) Netherlands 600; Belgium-Luxembourg 139; United Kingdom 67.	
Distillate fuel oil	do.	1,889	2,133	(^a) U.S.S.R. 1,286; Netherlands 600; Belgium-Luxembourg 112.	
Lubricants	do.	53	47	(^a) Netherlands 14; Belgium-Luxembourg 10; West Germany 8.	
Residual fuel oil	do.	595	528	— Mainly from U.S.S.R.	
Bitumen and other residues	do.	111	102	— All from Sweden.	
Bituminous mixtures	do.	2	2	(^a) Mainly from United Kingdom.	
Petroleum coke	do.	—	1	1	

NA Not available.

¹ Table prepared by P. J. Rontzel.

² Less than 1/2 unit.

³ Less than 50 kilograms.

⁴ Unreported quantity valued at \$500, all from the United States.

NORWAY⁸

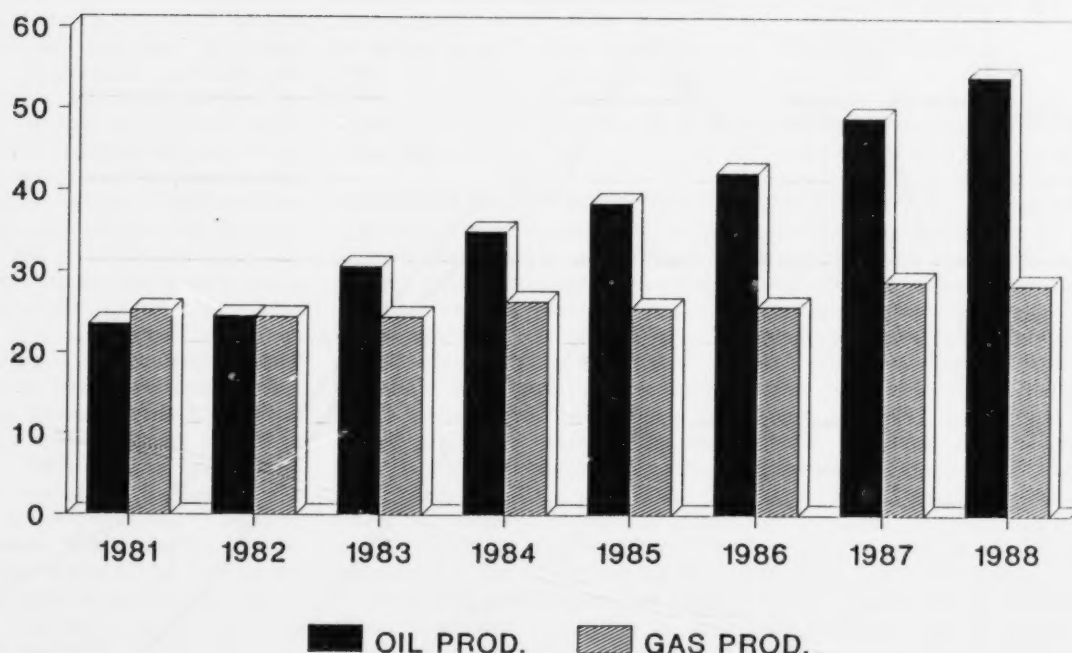
Production of primary aluminum and ferroalloys, each major energy-intensive industries, increased for the fourth consecutive year. The two Norwegian aluminum companies, Elkem and Norsk Hydro's, Hydro Aluminium A/S, made productivity improvements and rationalizations in both the aluminum and ferroalloy industries, which would have advantages on the European mainland in a 1992 market environment. Also, the Government restructured the steel industry and

formed Norsk Jern Holding A/S (NJH) in accordance with the Parliamentary resolution of June 9, 1988, and White Paper No. 113 (1987-88). The State owned all NJH stock formed from the previous Norsk Jernverk A/S. The changes reflect the decision of the Government that steel production based on iron ore would cease, and all scrap-steel production would be concentrated at Mo i Rana. The goal was that after restructuring, NJH would operate without the support of the State and would be a viable and profitable company. The iron ore mine products from Rana Gruber were to be

exported and to compete on the open market. However, since another source of manganese ore was unavailable, the Norwegian Government granted Elkem an extended exemption from the unilateral trade ban on South African manganese ores.

The petroleum production from 19 producing fields in the North Sea increased almost 10% in 1988, despite the continuation of the Government's mandated 7.5% production cutback (see figure 1). This cutback represented approximately 115,000 barrels per day. This reduction was not sufficient to offset record production levels attained

FIGURE 1
NORWEGIAN OIL AND GAS PRODUCTION
 (Million metric tons oil equivalent)



Source: The Royal Ministry of Petroleum and Energy--Norway

by the addition of new production. For example, the first oil production from the Osperg Field amounted to 100,000 barrels per day, and was ahead of schedule. The project was completed below estimated cost. Norwegian oil production at the level of 590 million barrels was expected to continue until the mid-1990's, after which, new discoveries would be required to stabilize a downward production trend (see figure 2). In 1988, 397.94 million barrels of oil, 27.23 million barrels of natural gas

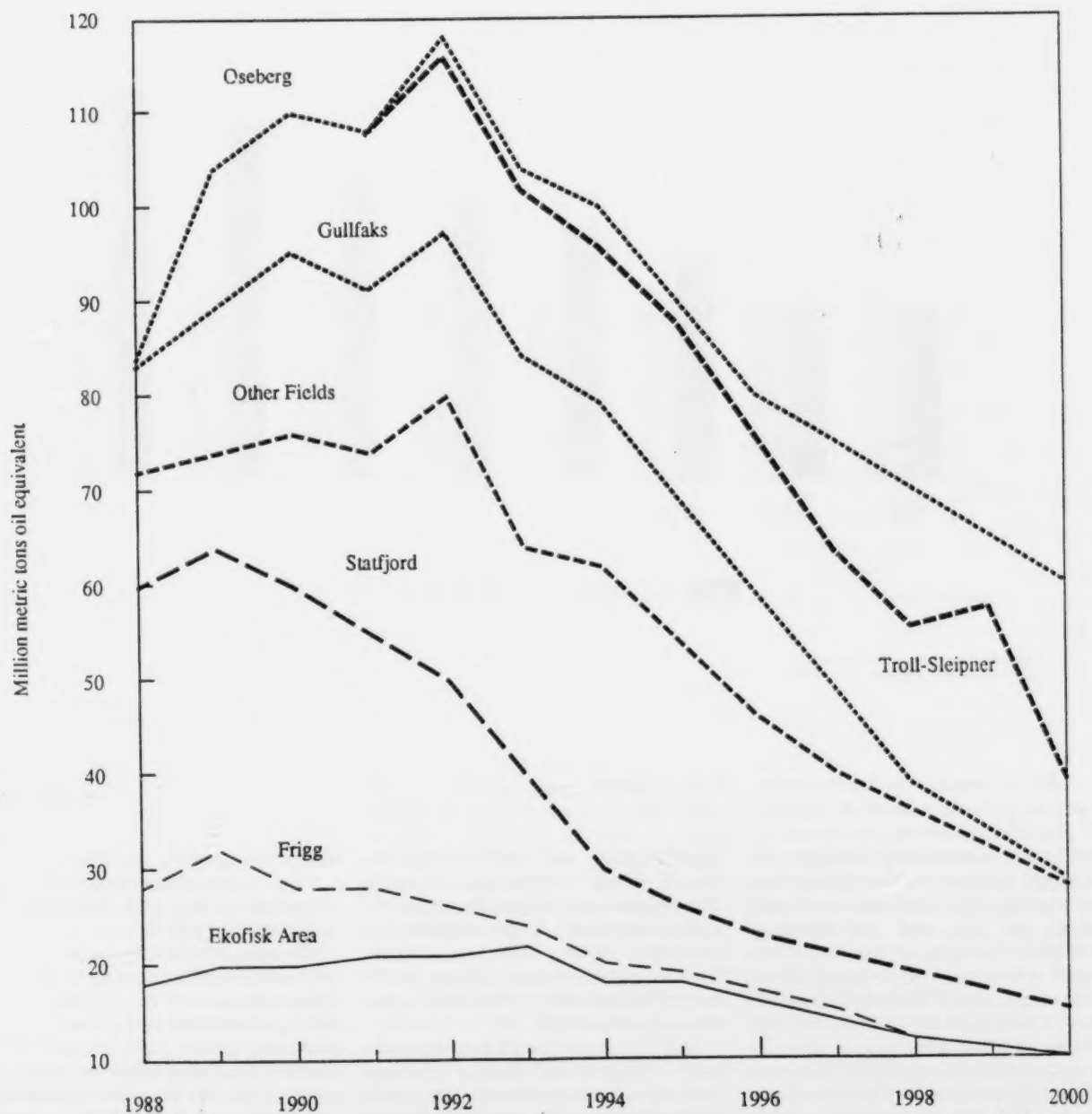
liquids (NGL), and 1,002.94 billion cubic feet of gas were produced from the Norwegian sector of the North Sea. Of the oil produced, 14.8% remained in Norway. Exports were as follows: 29.7% to the United Kingdom, 14.1% to the Netherlands, 9.7% to the United States, and so forth.

Sale of natural gas on long-term contracts to continental Europe continued with the agreement between the owners of Troll Field and the Spanish company, Enagas. Enron Co., an American com-

pany, Statoil A/S, and Norsk Hydro initiated a cooperation agreement to sell Norwegian LNG to the American market in the mid-1990's.

Exploratory drilling proved the most promising offshore area to be the Håltbank area of the Norwegian Sea with six new fields discovered. On the contrary, all 39 wells drilled in the Barents Sea have failed to find commercial oil reserves. The natural gas discoveries were classified as uneconomical, due to the high cost of off-

FIGURE 2
FORECAST OF NORWEGIAN PRODUCTION
 (Million metric tons oil equivalent)



Source: The Royal Ministry of Petroleum and Energy--Norway.

shore production facilities, the environmental considerations, and the distance and costs to ship the products to market. To meet these requirements, the Government's short-term goal was to award additional blocks, in the Barents Sea, which had not been previously opened to exploration activities and would provide additional geologic information. In the 12th Round, phase A, 16 blocks were awarded in the North Sea; these mostly were localized around existing infrastructures, which was consistent with the priority for development adjacent to the present infrastructure. In the 12th License Round, phase B, in March 1988, 13 new blocks were awarded: 3 in the North Sea, 3 on Haltenbanken, 1 on Nordland II, and 6 in the Barents Sea. In September 1988, at the 12th Round, phase B, new key blocks were announced and were to be awarded in 1989. The goal was to place before the Norwegian Parliament, the Storting, in 1989, the issue of opening up Finnmark West, southern parts, Trons II and Trons III as well as the remaining areas of the Barents Sea. In 1988, the Storting approved the development of two fields, Snorre and Draugen, and revised and approved the Plan for development of Hod Field. At yearend, 9 fields were under development and 16 other fields under consideration for development.

Twenty-nine wells, eighteen exploration and eleven delineation wells, were initiated in the Norwegian waters, indicating a continuing decrease in activity since the high of 50 wells were drilled in 1985. Nineteen wells were drilled in the North Sea, six in the mid-Norwegian Continental Shelf, and four in the Barents Sea. Since the first well was drilled in 1966 in the Norwegian waters, a total of 598 wells, 429 exploration, and 169 delineation wells, have been drilled.

Norway's domestic market was sluggish and the pace of petroleum development in the North Sea was slower due to generally lower petroleum prices. The real GDP increased a modest 2.0%, unemployment increased to

3.2%, and inflation eased slightly to 6.2%. The tight economic policies of the Government contributed to an improvement in the overall current trade account balance. This balance improved from a \$4.85 billion⁹ deficit to an approximate \$2.0 billion deficit in 1988. The import values increased by 2.4%, and export goods increased by 6.3%, in spite of a 15% decrease in oil prices from 1987.

Government Policies and Programs

Although Norway and other Nordic countries had not become members of the EC, trade agreements with the EC countries were in place. In fact, the Norwegian electorate elected in 1972 not to join the EC; however, this was before the big North Sea discoveries, which transformed the country and helped modernize many of its industries. Norwegian companies were in competition with EC countries for the North Sea business and had to adjust to EC standards and practices. The importance of the EC market has led to the formation of strategies that would allow Norwegian companies to take advantage and compete effectively in the 1992 market environment.

Production

The output of metals, particularly aluminum, primary steel, and ferroalloys, increased significantly due to the strong worldwide demand for metal products. The mining industry fared less favorably because of overseas competition and Government reorganizations. Output of crude oil continued to increase significantly, and the production of natural gas, limited by the availability of production facilities and pipelines, was expected to remain stable for the next few years.

Trade

Total exports of North Sea crude oil and natural gas decreased in value, in response to slightly lower prices for all hydrocarbon products. Total U.S. exports to Norway increased by 11% to

\$932 million, and Norwegian exports to the United States, which included crude oil, metals, and fertilizers, increased marginally to \$1,561 million from \$1,514 million in 1987.

Commodity Review

Metals.—Aluminum.—Norsk Hydro acquired the remaining 30% interest in Hydro Aluminium, and made it a wholly owned subsidiary. This subsidiary produced 620,000 tons of primary aluminum at four wholly owned and one partially owned Norsk Hydro plant in Norway. The annual capacities of the company's four primary aluminum plants were as follows: Karmoy Fabrikker, 220,000 tons; Ardal Verk, 185,000 tons; Sunndal Verk, 140,000 tons; and Hoyanger Verk, 70,000 tons. Improvements at several smelters resulted in increased production of 19,000 tons over 1987 production levels. One-half of the total production goes to the company's own semifabricating plants in nine European countries and the United States. Norsk Aluminium A/S was reorganized into five groups with the addition of the Rolled Products and of the Technology groups to the previous three units of Metal, Extrusion, and Fabricating. The consumption and the price of aluminum increased strongly in 1988, resulting in additional production by yearend. The Extrusion Group's plants operated at full capacity due to the strong European market. The Rolled Products markets were also good; however, the rapid increase in prices led to pressures on profit margins.

Expansion of the Karmoy aluminum smelter, Karmoy Farbrikker, was completed and put into full production. The new rated capacity was 220,000 tons per year. Two old potlines, representing about 50% of capacity, were of the Soderberg design, and the remaining cells, which were totally enclosed to prevent excessive fume emission, used prebaked anodes in accordance with a modified Pechiney design. The Government approved a proposal to moder-

TABLE 7
NORWAY: PRODUCTION OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1984	1985	1986	1987	1988 ^p
METALS					
Aluminum:					
Primary	765,083	742,686	725,813	806,092	864,190
Secondary	5,587	6,004	*6,000	*6,000	*6,000
Cadmium, smelter	150	159	154	147	169
Cobalt	1,191	1,637	1,574	1,576	1,852
Copper:					
Mine output, Cu content	25,042	18,969	21,887	21,984	15,877
Metal, primary plus secondary:					
Smelter	36,821	37,828	35,202	29,701	³ 31,729
Refined	30,323	31,074	30,457	29,386	³ 31,729
Iron and steel:					
Iron ore and concentrate:					
Gross weight thousand tons	3,837	3,497	3,618	3,140	3,242
Fe content do.	2,500	2,321	2,377	*2,060	2,126
Metal:					
Pig iron do.	546	596	564	365	367
Ferroalloys:					
Ferromanganese	285,169	267,670	195,257	191,992	361,345
Ferrosilicomanganese	280,953	256,457	223,490	237,277	232,501
Ferrosilicon (75% basis)	437,164	397,776	352,572	336,168	380,976
Total	1,003,286	921,903	753,788	765,437	974,822
Steel, crude thousand tons	920	958	836	837	907
Semimanufactures, rolled do.	615	664	687	*700	*700
Lead, mine output, Pb content	3,967	3,597	3,366	3,100	³ 2,801
Magnesium, primary	49,301	54,704	56,864	56,907	50,317
Nickel:					
Mine output, Ni content	325	425	438	496	*500
Metal, primary	35,548	37,513	38,202	44,565	³ 52,547
Platinum-group metals ² troy ounces	44,529	44,079	51,440	*50,000	*50,000
Silicon metal	89,398	105,552	*100,000	*90,000	*90,000
Zinc:					
Mine output, Zn content	28,513	27,352	27,508	22,164	³ 17,783
Metal, primary	94,248	92,762	90,475	116,468	³ 121,156
INDUSTRIAL MINERALS					
Cement, hydraulic thousand tons	1,547	1,343	1,625	1,639	³ 1,428
Feldspar	67,820	80,095	87,257	*90,000	*90,000
Gallium ^o kilograms	—	—	—	1,000	1,000
Gold ^o troy ounces	—	300	3,000	30,000	30,000
Graphite	10,067	2,684	—	—	—
Lime, hydrated, and quicklime ^o thousand tons	130	100	100	100	100
Mica, flake ^o	4,000	4,000	3,000	3,000	3,000
Nepheline syenite thousand tons	226	227	218	242	*250
Nitrogen: N content of ammonia do.	636	458	300	347	424

See footnotes at end of table.

TABLE 7—Continued
NORWAY: PRODUCTION OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity		1984	1985	1986	1987	1988 ²
INDUSTRIAL MINERALS—Continued						
Olivine sand	thousand tons	1,772	1,989	2,537	1,912	^e 2,000
Pyrite	do.	428	395	380	358	^e 350
Stone, crushed:						
Dolomite	do.	534	555	^e 550	^e 550	^e 550
Limestone	do.	3,995	3,827	^e 4,000	^e 4,000	^e 4,000
Quartz and quartzite	do.	828	775	^e 800	^e 800	^e 800
Sulfur:						
Pyrite, S content	do.	203	193	181	^e 180	^e 170
Byproduct of:						
Metallurgy	do.	62	60	67	^e 85	^e 80
Petroleum	do.	8	10	^e 13	^e 10	^e 10
Total	do.	273	263	261	^e275	^e260
Talc, soapstone, steatite ^e	do.	³ 113	100	100	100	100
Titania:						
Ilmenite concentrate	do.	652	736	804	852	^e 875
TiO ₂ content	do.	289	327	357	378	^e 385
MINERAL FUELS AND RELATED MATERIALS						
Coal, all grades	thousand tons	451	507	437	448	275
Coke, all grades	do.	337	313	313	284	^e 275
Gas:						
Manufactured	million cubic feet	73	—	—	—	—
Natural:						
Gross	billion cubic feet	1,144	1,202	1,119	1,216	^e 1,220
Marketable ⁴	do.	964	983	973	1,076	^e 1,080
Marketed ⁵	do.	944	898	829	998	1,003
Peat: ⁶						
For agricultural use	thousand tons	30	30	30	30	30
For fuel use	do.	1	1	1	1	1
Petroleum:						
Crude ⁶	thousand 42-gallon barrels	251,500	276,700	295,700	344,000	397,947
Natural gas liquids	do.	14,730	16,440	21,720	22,470	27,230
Refinery products:						
Naphtha	do.	3,429	3,834	3,618	4,419	^e 4,500
Gasoline	do.	11,849	11,466	10,548	12,248	^e 12,500
Kerosene	do.	4,687	5,906	5,549	6,402	^e 6,500
Distillate fuel oil	do.	24,767	26,811	27,199	33,756	^e 35,000
Residual fuel oil	do.	6,693	4,942	5,934	6,973	^e 7,000
Other	do.	3,972	3,897	3,380	4,050	^e 4,200
Refinery fuel and losses	do.	3,642	4,277	3,823	3,795	^e 4,000
Total	do.	59,039	61,133	60,051	71,643	^e73,700

^eEstimated. ²Preliminary. ³Revised.

¹Table includes data available through Sept. 15, 1989.

²Data represent exports, part of which may be derived from imported materials.

³Reported figure.

⁴Gross less gas reinjected and flared.

⁵Reported as total methane sales.

⁶Excluding natural gas liquids. The crude oil entry in 1985 Norway chapter included natural gas liquids content.

TABLE 8
NORWAY: EXPORTS OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity	1986	1987	Destinations, 1987		
			United States	Other (principal)	
METALS					
Aluminum:					
Ore and concentrate	60	1,400	—	All to Sweden.	
Oxides and hydroxides	12,642	17,764	—	United Kingdom 17,661; Sweden 86.	
Metal including alloys:					
Scrap	31,126	38,156	—	West Germany 14,621; Sweden 8,876; Netherlands 6,218.	
Unwrought	646,539	757,615	4,211	West Germany 206,253; Netherlands 138,007; United Kingdom 116,021.	
Semimanufactures	85,833	100,430	3,748	United Kingdom 19,765; Sweden 13,852; Denmark 13,570.	
Beryllium: Metal including alloys, all forms	—	(²)	—	All to Denmark.	
Cadmium: Metal including alloys, all forms	162	135	27	Sweden 47; West Germany 35.	
Chromium: Oxides and hydroxides	—	1	—	Mainly to Sweden.	
Cobalt:					
Oxides and hydroxides	(²)	—			
Metal including alloys, all forms	1,638	1,613	715	Netherlands 330; Japan 216.	
Copper:					
Ore and concentrate	106,237	115,880	—	Finland 52,388; West Germany 48,110; Sweden 12,356.	
Matte and speiss including cement copper	—	(²)	—	All to Singapore.	
Oxides and hydroxides	NA	3,513	NA	NA.	
Sulfate	NA	123	—	All to U.S.S.R.	
Ash and residue containing copper	NA	3,108	NA	Spain 2,210; Republic of Korea 848.	
Metal including alloys:					
Scrap	7,316	9,683	—	West Germany 5,282; Belgium-Luxembourg 1,516; Denmark 861.	
Unwrought	34,558	30,865	186	West Germany 8,214; Sweden 6,409; United Kingdom 6,292.	
Semimanufactures	2,640	2,794	23	Sweden 761; Denmark 534; West Germany 406.	
Gold:					
Waste and sweepings	value, thousands	\$927	\$1,179	NA	West Germany \$643; Switzerland \$198; United Kingdom \$185.
Metal including alloys, unwrought and partly wrought	troy ounces	10,192	23,341	NA	West Germany 8,005; Sweden 5,112; France 4,212.
Iron and steel:					
Iron ore and concentrate:					
Excluding roasted pyrite	thousand tons	2,532	2,530	—	United Kingdom 1,181; West Germany 446; France 339.
Pyrite, roasted	do.	8	28	—	Denmark 25; Netherlands 3.

See footnotes at end of table.

TABLE 8—Continued
NORWAY: EXPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1986	1987	Destinations, 1987	
			United States	Other (principal)
METALS—Continued				
Iron and steel—Continued				
Metal:				
Scrap	7,704	11,897	-1	West Germany 2,224; Sweden 2,135; United Kingdom 2,052.
Pig iron, cast iron, related materials	22,898	14,453	—	United Kingdom 10,847; Sweden 2,007; Spain 993.
Ferroalloys:				
Ferrochromium	—	4	—	NA.
Ferromanganese	162,265	176,850	21,418	West Germany 29,275; United Kingdom 19,894.
Ferrosilicomanganese	202,090	215,810	26,458	West Germany 44,190; Belgium-Luxembourg 38,285; France 27,266.
Ferrosilicon	339,711	334,761	16,662	West Germany 102,023; Japan 75,350; United Kingdom 48,516.
Silicon metal	NA	81,066	50	West Germany 33,139; United Kingdom 11,062; Japan 10,209.
Unspecified	11,515	11,125	—	United Kingdom 4,507; France 1,965; West Germany 1,545.
Steel, primary forms	41,353	122,410	41,259	Netherlands 26,651; Italy 22,667.
Semimanufactures:				
Bars, rods, angles, shapes, sections	299,127	399,127	106,658	West Germany 89,724; United Kingdom 50,406.
Universals, plates, sheets	150,097	149,237	14,824	United Kingdom 35,402; Sweden 33,269; Denmark 27,707.
Hoop and strip	16,350	20,059	34	Sweden 17,360; Denmark 1,861; United Kingdom 424.
Rails and accessories	2,223	3,012	—	Italy 1,700; Sweden 653; Netherlands 613.
Wire	9,798	10,047	2,418	United Kingdom 1,823; Sweden 859; West Germany 849.
Tubes, pipes, fittings	56,428	61,442	360	Sweden 32,901; Denmark 7,370; Finland 6,957.
Castings and forgings, rough	3,198	3,965	3	Sweden 3,470; United Kingdom 133; Switzerland 130.
Lead:				
Ore and concentrate	7,180	6,026	—	All to West Germany.
Oxides	16	—	—	
Metal including alloys:				
Scrap	7,171	8,308	—	Sweden 7,785; West Germany 172.
Unwrought	28	35	—	Mainly to Sweden.
Semimanufactures	1	3	—	All to Sweden.
Magnesium: Metal including alloys:				
Scrap	103	149	—	All to West Germany.
Unwrought	value, thousands	\$146,530	\$150,645	NA
			NA	NA.

See footnotes at end of table.

TABLE 8—Continued
NORWAY: EXPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1986	1987	Destinations, 1987	
			United States	Other (principal)
METALS—Continued				
Magnesium—Continued				
Semimanufactures	164	1,202	1,088	United Kingdom 42; Switzerland 29.
Manganese: Ore and concentrate, metallurgical-grade	505	5	—	All to Sweden.
Mercury 76-pound flasks	870	2,118	—	West Germany 1,131; Spain 783.
Molybdenum: Metal including alloys, all forms	1	—		
Nickel:				
Ore and concentrate	11,871	8,991	—	All to Finland.
Matte and speiss	—	(^a)	NA	NA.
Metal including alloys:				
Scrap	108	91	50	Austria 40; West Germany 1.
Unwrought	37,917	44,125	19,359	Netherlands 7,673; Japan 3,383.
Semimanufactures	30	859	—	Netherlands 575; Finland 186; Austria 34.
Platinum-group metals: Metals including alloys, unwrought and partly wrought troy ounces	51,441	63,498	514	West Germany 33,372; United Kingdom 14,146; France 9,742.
Silver:				
Waste and sweepings ³ value, thousands	\$2,761	\$3,381	—	West Germany \$1,821; United Kingdom \$1,516.
Metal including alloys, unwrought and partly wrought thousand troy ounces	1,200	1,040	(^a)	Sweden 467; Denmark 249; Canada 200.
Tin: Metal including alloys:				
Scrap	12	21	—	United Kingdom 13; Sweden 8.
Unwrought	5	5	—	Sweden 4; Finland 1.
Semimanufactures	23	22	(^a)	West Germany 19; United Kingdom 3.
Titanium:				
Ore and concentrate	693,265	715,915	NA	NA.
Oxides	1,253	6,740	508	West Germany 5,007; Sweden 958.
Tungsten: Metal including alloys, all forms	(^a)	(^a)	—	Mainly to Sweden.
Uranium and thorium: Metals including alloys, waste and scrap	NA	3	3	
Zinc:				
Ore and concentrate	8,355	7,185	—	All to West Germany.
Oxides	3,004	3,358	—	United Kingdom 2,461; West Germany 377; Sweden 187.
Ash and residue containing zinc	NA	347	NA	NA.
Metal including alloys:				
Scrap	539	590	—	Sweden 307; United Kingdom 207; India 55.
Unwrought	77,235	106,196	20,695	West Germany 23,701; Sweden 20,034.
Semimanufactures	6,636	7,779	17	Netherlands 1,283; West Germany 1,001; Singapore 998.

See footnotes at end of table.

TABLE 8—Continued
NORWAY: EXPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1986	1987	United States	Destinations, 1987
				Other (principal)
METALS—Continued				
Other:				
Ashes and residues	18,134	22,485	(²)	France 9,955; Belgium-Luxembourg 4,104; West Germany 2,925.
Base metals including alloys, all forms	59	29	NA	NA.
INDUSTRIAL MINERALS				
Abrasives, n.e.s.:				
Natural: Corundum, emery, pumice, etc.	22	63	—	Iceland 38; Tanzania 25.
Artificial:				
Corundum	4	6	—	Egypt 2; Netherlands 1; United Arab Emirates 1.
Silicon carbide	NA	60,208	NA	NA.
Dust and powder of precious and semiprecious stones including diamond kilograms	1	6	—	Mainly to Sweden.
Grinding and polishing wheels and stones	690	516	20	Sweden 185; Finland 128.
Asbestos, crude	1	—		
Barite and witherite	10,053	22,613	—	United Kingdom 14,520; Denmark 7,115; Sweden 892.
Boron materials: Crude natural borates	—	1	—	All to France.
Cement	653	865	NA	Sweden 827.
Chalk	3	(²)	NA	NA.
Clays, crude	103	630	—	Sweden 592; Denmark 33.
Cryolite and chiolite	2	2	—	All to Sweden.
Diamond, natural:				
Gem, not set or strung value, thousands	\$103	\$228	—	Belgium-Luxembourg \$172; United Kingdom \$40.
Industrial stones do.	\$13	—		
Diatomite and other infusorial earth	(²)	11	—	Mainly to Qatar.
Feldspar, fluor spar, related materials:				
Feldspar	74,185	74,953	—	West Germany 17,538; United Kingdom 15,700; Netherlands 12,749.
Leucite, nepheline, nepheline syenite	228,662	256,005	—	Netherlands 99,365; United Kingdom 46,042; West Germany 37,945.
Fertilizer materials:				
Crude, n.e.s.	1	—		
Manufactured:				
Ammonia value, thousands	\$1,608	\$651	NA	NA.
Nitrogenous do.	\$81,677	\$85,391	NA	NA.
Potassic do.	\$3	\$2	—	All to West Germany.
Unspecified and mixed do.	\$155,247	\$178,595	NA	NA.
Graphite, natural	954	56	NA	NA.
Gypsum and plaster	29	19	—	All to Sweden.

See footnotes at end of table.

TABLE 8—Continued
NORWAY: EXPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1986	1987	United States	Destinations, 1987
				Other (principal)
INDUSTRIAL MINERALS—Continued				
Lime	4,860	8,015	—	Liberia 7,000; Denmark 961.
Magnesium compounds	8,689	4,170	NA	NA.
Mica:				
Crude including splittings and waste	1,422	1,916	—	West Germany 681; Netherlands 537; Sweden 140.
Worked including agglomerated splittings	(²)	(²)	—	All to Sweden.
Phosphates, crude	—	2,400	—	All to Denmark.
Phosphorus, elemental	NA	80	—	All to Hungary.
Pigments, mineral: Iron oxides and hydroxides, processed	44	28	—	West Germany 15; Thailand 10; Malaysia 3.
Precious and semiprecious stones other than diamond:				
Natural kilograms	3,991	3,306	—	Mainly to Denmark and West Germany.
Synthetic do.	490	—	—	—
Pyrite, unroasted	172,650	108,080	—	West Germany 52,985; Sweden 21,663; Turkey 18,237.
Salt and brine	2,487	1,377	—	Sweden 775; West Germany 600.
Sodium compounds, n.e.s.:				
Carbonate, manufactured	23	9	—	Sweden 8.
Sulfate, manufactured	(²)	13	NA	NA.
Stone, sand and gravel:				
Dimension stone:				
Crude and partly worked	270,184	113,906	1,228	Italy 37,533; France 32,744; Spain 13,070.
Worked	11,819	16,116	57	Netherlands 13,785; Sweden 602.
Dolomite, chiefly refractory-grade	168,259	182,161	NA	NA.
Gravel and crushed rock	4,120,216	4,333,300	853	West Germany 1,391,496; Denmark 640,929; Netherlands 563,285.
Limestone other than dimension	4,446	10,832	—	United Kingdom 5,979; Sweden 4,007.
Quartz and quartzite	123,961	47,401	—	Iceland 45,665; Sweden 1,010.
Sand other than metal-bearing	3,386	18,437	—	United Kingdom 17,556; United Arab Emirates 400.
Sulfur:				
Elemental:				
Crude including native and byproduct	2,643	739	—	West Germany 695; Sweden 39.
Colloidal, precipitated, sublimed	2,751	2,799	—	All to Sweden.
Dioxide including trioxide	NA	8,509	NA	Sweden 7,935.
Sulfuric acid value, thousands	\$8,283	\$7,755	NA	NA.
Talc, steatite, soapstone, pyrophyllite	42,702	45,100	—	United Kingdom 11,171; West Germany 9,895; Netherlands 8,837.

See footnotes at end of table.

TABLE 8—Continued

NORWAY: EXPORTS OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity	1986	1987	United States	Destinations, 1987	
					Other (principal)
INDUSTRIAL MINERALS—Continued					
Other:					
Crude	788	2,176	—	Italy 1,713; Sweden 436.	
Slag and dross, not metal-bearing	17,698	57,211	—	Denmark 23,381; France 9,955; Sweden 9,160.	
MINERAL FUELS AND RELATED MATERIALS					
Asphalt and bitumen, natural	1,565	1,425	—	West Germany 1,229; Iceland 144.	
Carbon black	6	19	(²)	Sweden 18.	
Coal: Anthracite and bituminous	122,726	203,239	NA	West Germany 81,070; France 51,510; United Kingdom 33,234.	
Coke and semicoke	124,984	159,252	—	Sweden 56,674; Finland 29,656; Iceland 21,483.	
Gas, natural: Gaseous	million cubic feet	900,943	982,576	—	West Germany 544,580; United Kingdom 437,996.
Peat including briquets and litter		385	2,618	—	Denmark 1,366; United Kingdom 771; Belgium-Luxembourg 375.
Petroleum:					
Crude	thousand 42-gallon barrels	264,366	310,762	9,876	United Kingdom 173,889; Netherlands 43,653; Sweden 29,626.
Refinery products:					
Liquefied petroleum gas	do.	1,543	10,969	1,003	Sweden 2,521; Netherlands 1,718; United Kingdom 1,453.
Gasoline, motor	do.	5,302	5,235	25	Sweden 3,242; Netherlands 605; Belgium-Luxembourg 409.
Mineral jelly and wax	do.	(²)	(²)	NA	NA.
Kerosene and jet fuel	do.	1,634	2,071	15	Sweden 824; Netherlands 443; United Kingdom 392.
Distillate fuel oil	do.	5,230	6,998	65	Sweden 2,619; East Germany 1,912; United Kingdom 927.
Lubricants	do.	47	695	8	Sweden 296; United Kingdom 208; Belgium-Luxembourg 67.
Residual fuel oil	do.	6,318	3,693	25	East Germany 1,216; Sweden 870; U.S.S.R. 818.
Bitumen and other residues	do.	24	634	NA	Netherlands 466; West Germany 59; Malta 36.
Bituminous mixtures	do.	4	88	(²)	Sweden 82; Netherlands 2; West Germany 1.
Petroleum coke	do.	446	1,684	1,224	United Kingdom 370; Netherlands 67.

NA Not available.

¹ Table prepared by Gio Jacarepaqua.² Less than 1/2 unit.³ May include other precious metals.

TABLE 9
NORWAY: IMPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1986	1987	United States	Sources, 1987	
				Other (principal)	
METALS					
Aluminum:					
Ore and concentrate	5,871	5,792	—	Greece 5,768; Netherlands 20.	
Oxides and hydroxides	thousand tons	1,496	1,645	50	Suriname 678; Australia 345; Venezuela 181.
Metal including alloys:					
Scrap	3,213	1,417	—	Denmark 810; West Germany 262; Sweden 168.	
Unwrought	35,118	57,146	741	Romania 16,748; U.S.S.R. 13,261; Brazil 9,278.	
Semimanufactures	54,410	36,518	131	West Germany 12,364; Sweden 7,262; Belgium-Luxembourg 3,105.	
Antimony: Metal including alloys, all forms	26	55	NA	China 43.	
Beryllium: Metal including alloys, all forms	(²)	21	—	West Germany 20; Sweden 1.	
Chromium:					
Ore and concentrate	520	760	—	Turkey 476; Finland 131; West Germany 56.	
Oxides and hydroxides	152	191	(²)	West Germany 180; China 10.	
Metal including alloys, all forms	NA	39	NA	NA.	
Cobalt:					
Oxides and hydroxides	1	1	—	Mainly from China.	
Metal including alloys, all forms	370	1	NA	NA.	
Columbium and tantalum: Metal including alloys, semimanufactures: Tantalum					
	(²)	(²)	(²)	Mainly from Switzerland.	
Copper:					
Matte and speiss including cement copper	584	27	—	Belgium-Luxembourg 23; Sweden 4.	
Oxides and hydroxides	NA	42	NA	NA.	
Sulfate	NA	2,032	NA	U.S.S.R. 1,134; West Germany 311; Hungary 305.	
Metal including alloys:					
Scrap	56	309	176	Sweden 124.	
Unwrought	3,080	2,940	—	West Germany 985; Sweden 759; United Kingdom 638.	
Semimanufactures	31,352	28,466	54	Belgium-Luxembourg 8,153; Sweden 7,440; West Germany 7,304.	
Gold:					
Waste and sweepings	value, thousands	\$639	\$1,864	—	Sweden \$1,551; West Germany \$306.
Metal including alloys, unwrought and partly wrought	troy ounces	24,209	17,811	932	West Germany 10,738; United Kingdom 1,833; Switzerland 1,479.
Iron and steel:					
Iron ore and concentrate excluding roasted pyrite	17,715	20,637	—	All from Sweden.	
Metal:					
Scrap	6,145	32,528	604	West Germany 29,674; Denmark 1,433; Sweden 648.	

See footnotes at end of table.

TABLE 9—Continued
NORWAY: IMPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1986	1987	Sources, 1987	
			United States	Other (principal)
METALS—Continued				
Iron and steel—Continued				
Metal—Continued				
Pig iron, cast iron, related materials	7,432	6,798	1	Sweden 2,978; United Kingdom 1,370; Canada 862.
Ferroalloys:				
Ferrochromium	830	652	NA	Sweden 585; West Germany 28.
Ferromanganese	—	3,130	—	France 3,129.
Ferromolybdenum	NA	52	NA	United Kingdom 23.
Ferrosilicomanganese	NA	2,401	—	France 1,401; West Germany 1,000.
Ferrosilicon	995	630	NA	West Germany 392; Sweden 225.
Ferrotitanium	NA	8	NA	NA.
Ferrotungsten	NA	6	NA	NA.
Ferrovandium	NA	30	6	West Germany 10; Austria 6; Brazil 6.
Silicon metal	NA	30	NA	NA.
Unspecified	564	208	38	Italy 63; West Germany 49.
Steel, primary forms	131,162	146,636	(²)	West Germany 59,165; Netherlands 57,850; France 11,388.
Semimanufactures:				
Bars, rods, angles, shapes, sections	276,329	257,836	5	Sweden 59,015; West Germany 46,009; Belgium-Luxembourg 27,567.
Universals, plates, sheets	517,587	450,386	92	Sweden 113,555; United Kingdom 67,059; Belgium-Luxembourg 64,865.
Hoop and strip	36,148	36,082	1	West Germany 10,778; Sweden 9,355; United Kingdom 3,547.
Rails and accessories	17,407	10,784	—	Sweden 9,132; United Kingdom 674; West Germany 525.
Wire	20,047	18,497	58	Belgium-Luxembourg 5,447; Sweden 5,206; France 2,984.
Tubes, pipes, fittings	200,530	191,699	910	Japan 48,937; West Germany 39,129; United Kingdom 24,076.
Castings and forgings, rough	5,429	5,575	1	Sweden 2,296; Denmark 2,090; West Germany 288.
Lead:				
Oxides	175	79	(²)	West Germany 62; United Kingdom 15.
Metal including alloys:				
Scrap	—	10	—	All from Denmark.
Unwrought	14,231	13,468	—	Sweden 11,880; United Kingdom 1,311; Netherlands 140.
Semimanufactures	2,763	1,664	(²)	Netherlands 917; West Germany 350; Belgium-Luxembourg 177.
Magnesium: Metal including alloys:				
Scrap	(²)	73	—	United Kingdom 51; Netherlands 21.

See footnotes at end of table.

TABLE 9--Continued
NORWAY: IMPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1986	1987	Sources, 1987	
			United States	Other (principal)
METALS—Continued				
Magnesium—Continued				
Unwrought	1,335	1,385	1,090	Netherlands 177; United Kingdom 53.
Semimanufactures	64	44	—	United Kingdom 26; West Germany 15.
Manganese:				
Ore and concentrate, metallurgical-grade	817,544	628,173	265	Gabon 253,575; Republic of South Africa 135,562; France 93,693.
Oxides	1,290	1,523	—	Netherlands 924; Belgium-Luxembourg 479.
Metal including alloys, all forms	1,315	1,641	344	Belgium-Luxembourg 486; Republic of South Africa 405.
Mercury 76-pound flasks	87	232	—	West Germany 116; China 87.
Molybdenum: Metal including alloys, all forms	7	1	(²)	Mainly from United Kingdom.
Nickel:				
Ore and concentrate	—	25	(²)	Mainly from Australia.
Matte and speiss	101,073	92,110	—	Canada 60,958; Botswana 29,510; Zimbabwe 747.
Metal including alloys:				
Scrap	12	11	—	All from United Kingdom.
Unwrought	154	64	—	United Kingdom 53; Belgium-Luxembourg 5; Finland 4.
Semimanufactures	292	264	17	United Kingdom 77; West Germany 76; Switzerland 35.
Platinum-group metals: Metals including alloys, unwrought and partly wrought troy ounces	21,509	25,270	1,029	U.S.S.R. 9,710; United Kingdom 6,719; Switzerland 4,598.
Silver:				
Waste and sweepings ³ value, thousands	\$4,525	\$5,584	—	Sweden \$3,084; United Kingdom \$1,648; Finland \$234.
Metal including alloys, unwrought and partly wrought thousand troy ounces	2,349	1,902	(²)	West Germany 834; United Kingdom 443; Switzerland 294.
Tin: Metal including alloys:				
Scrap	1	—	—	—
Unwrought	562	481	—	United Kingdom 284; Sweden 65; Netherlands 63.
Semimanufactures	185	177	(²)	United Kingdom 75; West Germany 57; Sweden 25.
Titanium:				
Ore and concentrate	NA	1	—	Mainly from United Kingdom.
Oxides	1,668	777	—	West Germany 471; Netherlands 225; Finland 50.
Tungsten: Metal including alloys, all forms	2	7	(²)	West Germany 4; United Kingdom 1.
Uranium and thorium: Metals including alloys, all forms	(²)	1	1	—

See footnotes at end of table.

TABLE 9—Continued
NORWAY: IMPORTS OF MINERAL COMMODITIES¹

(Metric tons unless otherwise specified)

Commodity	1986	1987	Sources, 1987	
			United States	Other (principal)
METALS—Continued				
Zinc:				
Ore and concentrate	110,468	171,939	—	Sweden 103,036; Canada 58,599; Denmark 5,549.
Oxides	2,503	2,728	—	East Germany 2,070; Sweden 216; West Germany 207.
Ash and residue containing zinc	NA	17,754	109	Sweden 15,995; Denmark 1,755.
Metal including alloys:				
Scrap	5,900	3,959	1	Denmark 1,564; Finland 1,354; Sweden 1,035.
Unwrought	377	855	—	Finland 346; West Germany 276; Sweden 102.
Semimanufactures	1,012	812	(²)	France 270; West Germany 231; Poland 110.
Other:				
Ores and concentrates	3,926	26,462	56	Sweden 26,406.
Ashes and residues	266,610	309,046	12	West Germany 243,742; East Germany 62,268; France 2,968.
Base metals including alloys, all forms	124	87	14	West Germany 46; Sweden 4.
INDUSTRIAL MINERALS				
Abrasives, n.e.s.:				
Natural: Corundum, emery, pumice, etc.	12,420	18,507	56	Iceland 17,582; United Kingdom 293; West Germany 167.
Artificial:				
Corundum	610	825	—	West Germany 589; United Kingdom 104; Hungary 53.
Silicon carbide	NA	94	NA	West Germany 82.
Dust and powder of precious and semiprecious stones including diamond value, thousands	\$11	\$27	\$20	Netherlands \$4; United Kingdom \$3.
Grinding and polishing wheels and stones	1,046	955	15	Austria 235; West Germany 201; Sweden 189.
Asbestos, crude	1	11	11	
Barite and witherite	116,489	111,194	20	Morocco 87,590; Ireland 16,511; United Kingdom 6,062.
Boron materials:				
Crude natural borates	25	10	—	Mainly from Sweden.
Oxides and acids	388	374	246	France 94.
Cement	559,886	592,881	92	Sweden 353,091; Poland 89,701; West Germany 62,896.
Chalk	8,044	8,783	22	Denmark 5,026; Sweden 2,669; France 617.
Clays, crude	119,712	133,883	5,650	United Kingdom 90,484; Greece 19,215; Czechoslovakia 6,298.
Cryolite and chiolite	4,848	3,674	—	Denmark 3,256; Netherlands 418.

See footnotes at end of table.

TABLE 9—Continued
NORWAY: IMPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity		1986	1987	United States	Sources, 1987
					Other (principal)
INDUSTRIAL MINERALS—Continued					
Diamond natural:					
Gem, not set or strung	value, thousands	\$3,545	\$4,000	\$20	Belgium-Luxembourg \$2,139; United Kingdom \$700; West Germany \$297.
Industrial stones	do.	\$280	\$23	—	Netherlands \$13; United Kingdom \$5; Sweden \$4.
Diatomite and other infusorial earth		1,986	2,020	146	Iceland 1,066; Denmark 230; Spain 229.
Feldspar, fluorspar, related materials:					
Feldspar		187	82	—	NA.
Fluorspar		47,022	46,804	—	NA.
Fertilizer materials:					
Crude, n.e.s.		1	3	—	Mainly from Finland.
Manufactured:					
Ammonia		231,409	144,551	81,701	U.S.S.R. 42,288; Netherlands 10,278.
Nitrogenous		12,085	22,162	(^a)	Sweden 20,045; Denmark 1,123; Austria 230.
Phosphatic		2,568	1,793	—	Sweden 1,652; Netherlands 70.
Potassic		317,670	305,527	—	France 73,294; Spain 58,485; West Germany 47,930.
Unspecified and mixed		43,961	45,443	3	Belgium-Luxembourg 34,170; Sweden 3,918; West Germany 3,033.
Graphite, natural		8,211	233	1	Sweden 142; West Germany 56.
Gypsum and plaster		211,318	230,805	—	Spain 182,452; Sweden 22,262; France 15,210.
Kyanite and related materials		1,763	322	—	Netherlands 151.
Lime		33,750	27,797	1	Denmark 20,575; Sweden 5,950; United Kingdom 468.
Magnesium compounds:					
Magnesite, crude including oxides		6,911	9,292	2	China 4,173; Austria 2,078; Sweden 1,478.
Sulfate		NA	61,204	—	West Germany 44,367; East Germany 16,676.
Mica:					
Crude including splittings and waste		1,284	1,882	37	India 1,715; Netherlands 95.
Worked including agglomerated splittings		63	55	—	Switzerland 25; France 11; Belgium-Luxembourg 10.
Nitrates, crude		156	77	—	All from West Germany.
Phosphates, crude		445,807	475,426	56,754	Sweden 215,741; Morocco 100,260.
Phosphorus, elemental		NA	8	NA	NA.
Pigments, mineral: Iron oxides and hydroxides, processed		2,450	3,135	—	West Germany 2,934; Spain 94; Netherlands 42.

See footnotes at end of table.

TABLE 9—Continued
NORWAY: IMPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1986	1987	Sources, 1987		
			United States	Other (principal)	
INDUSTRIAL MINERALS—Continued					
Precious and semiprecious stones other than diamond:					
Natural	value, thousands	\$431	\$714	\$12	Sweden \$210; West Germany \$136; United Kingdom \$104.
Synthetic:					
Diamond	do.	NA	\$9	—	Mainly from France.
Other	do.	\$36	\$50	\$1	United Kingdom \$24; Switzerland \$18.
Pyrite, unroasted		3,948	—		
Salt and brine		555,603	596,368	6	Netherlands 373,355; Spain 62,730; United Kingdom 44,939.
Sodium compounds, n.e.s.:					
Carbonate, manufactured		48,869	47,552	590	Poland 18,539; Netherlands 10,297; West Germany 10,278.
Sulfate, manufactured		7,433	7,146	NA	Sweden 6,661; West Germany 220.
Stone, sand and gravel:					
Dimension stone:					
Crude and partly worked		10,149	9,963	1	Sweden 4,005; Portugal 3,389; Italy 1,177.
Worked		23,544	22,723	(²)	Portugal 11,320; Italy 3,962; Sweden 3,844.
Dolomite, chiefly refractory-grade		8,211	9,372	(²)	Sweden 5,662; United Kingdom 3,399; West Germany 286.
Gravel and crushed rock		63,225	74,000	—	Sweden 67,696; Denmark 5,398; Italy 362.
Limestone other than dimension		216,133	208,991	—	United Kingdom 122,417; France 70,178; Denmark 7,527.
Quartz and quartzite		589,369	641,980	3	Sweden 368,902; Spain 269,349; Belgium-Luxembourg 3,430.
Sand other than metal-bearing		209,636	200,223	245	Belgium-Luxembourg 126,913; Sweden 49,767; Denmark 15,872.
Sulfur:					
Elemental:					
Crude including native and byproduct		6,138	3,371	—	Sweden 3,225; West Germany 132.
Colloidal, precipitated, sublimed		11	30	—	United Kingdom 20; West Germany 10.
Dioxide including trioxide		—	4,126	NA	Sweden 4,114.
Sulfuric acid		1,937	149	(²)	Denmark 101; Sweden 39.
Talc, steatite, soapstone, pyrophyllite		6,302	6,207	63	Finland 2,126; India 2,125; Sweden 747.
Other:					
Crude		71,084	9,993	8	Sweden 7,097; Spain 1,282; Greece 1,100.
Slag and dross, not metal-bearing		164,431	175,095	—	Denmark 146,303; Sweden 14,461; Netherlands 9,566.
MINERAL FUELS AND RELATED MATERIALS					
Asphalt and bitumen, natural		58	92	92	
Carbon black		5,857	5,223	41	Sweden 2,889; Netherlands 1,378; United Kingdom 581.

See footnotes at end of table.

TABLE 9—Continued
NORWAY: IMPORTS OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1986	1987	United States	Sources, 1987
				Other (principal)
MINERAL FUELS AND RELATED MATERIALS—Continued				
Coal:				
Anthracite and bituminous	769,563	726,512	182,600	Poland 146,411; United Kingdom 103,855.
Briquets of anthracite and bituminous coal	2,000	18,918	10,403	West Germany 8,435.
Lignite including briquets	11	10	—	All from West Germany.
Coke and semicoke	600,709	503,677	1,994	United Kingdom 248,760; West Germany 81,205; East Germany 47,695.
Peat including briquets and litter	20,710	16,624	—	Sweden 16,421; Finland 144.
Petroleum:				
Crude	thousand 42-gallon barrels	14,794	19,547	—
				United Kingdom 11,684; Denmark 3,312; U.S.S.R. 2,632.
Refinery products:				
Liquefied petroleum gas	do.	2,726	3,236	NA
				NA.
Gasoline, motor	do.	6,678	5,235	25
				Sweden 3,242; Netherlands 605; Belgium-Luxembourg 409.
Mineral jelly and wax	do.	73	68	NA
				West Germany 49; United Kingdom 7; China 5.
Kerosene and jet fuel	do.	2,345	2,071	15
				Sweden 824; Netherlands 443; United Kingdom 392.
Distillate fuel oil	do.	8,600	6,998	65
				Sweden 2,619; East Germany 1,912; United Kingdom 927.
Lubricants	do.	683	695	8
				Sweden 296; United Kingdom 208; Belgium-Luxembourg 67.
Residual fuel oil	do.	5,356	3,693	25
				East Germany 1,216; Sweden 870; U.S.S.R. 818.
Bitumen and other residues	do.	1,323	3,436	1,413
				Sweden 1,159; United Kingdom 416.
Bituminous mixtures	do.	132	88	(²)
				Sweden 82; Netherlands 2; West Germany 1.
Petroleum coke	do.	2,007	1,684	1,224
				United Kingdom 370; Netherlands 67.

¹ Revised. NA Not available.

² Table prepared by Gio Jacarepaqua.

³ Less than 1/2 unit.

⁴ May include other precious metals.

⁵ Excludes unreported quantity of urea valued at \$5,176,000.

ize the cast house at Sunndal; this was to be completed in 1989. Other company efforts to stabilize smelter operations and increase labor productivity began to show rewards during the year, and these improvements were expected to continue into 1989. The increased consumption and production of aluminum led to a tight raw materials mar-

ket. In response to this, Norsk Hydro acquired a 35% interest in the Alpart alumina refinery in Jamaica, which would entitle Norsk Hydro to 350,000 tons per year of the aluminum output from the plant. This plant, which had been out of production since 1985, was restarted and was expected to produce 1 million tons per year of alumina by

1990. The Extrusion Group of Hydro Aluminum owned 17 extrusion plants in Europe and the United States. At yearend, sales of 214,000 tons of product were recorded and reflected a 12% increase over the 1987 sales volume. The company, one of Western Europe's leading aluminum extruders with an annual capacity of about 200,000 tons,

signed an agreement to acquire the German company Wicona. Wicona was one of Europe's leading companies in the production and marketing of building systems made from aluminum extrusions. To meet the increased market demand, several of the Norwegian extrusion plants were reorganized and strengthened in 1988.

Hydro Aluminium's Rolled Products Group included a foil mill in Copenhagen, rolling mills at Karmoy and Holmestrand, and a coating line in Holmestrand. The Group's total production increased to 85,000 tons, 14,000 tons more than in the previous year. Aluminum sheet rolling facilities consisted of the newly enlarged 90,000 tons per year, Nordisk Holmestrand; the hot and cold mills at Holmestrand, 55,000 tons per year; and at Karmoy, 30,000 tons per year.

Three other aluminum smelters, in addition to Hydro Aluminium's four units, operated in Norway. There were two plants at Mosjoen and Lista, owned by Elkem (50%) and the Aluminum Co. of America (50%), and the third plant at Husnes owned by Sor-Norge Aluminium A/S. Elkem sold 5% in its Norwegian plants for interest in Alcoa's Alcoa Nederland BV, and in return Alcoa received the 11% in British fabricating plant owned by Elkem. This exchange solidifies Elkem's marketing entry into the European market. The 25,000-ton-per-year increased capacity and modernization at the Mosjoen smelter was expected to reduce energy consumption and to comply with environmental regulations, but had to meet a 1989 completion date. In midyear, the Government considered the construction of a 200,000-ton-per-year aluminum smelter at Mo i Rana to employ workers who lost jobs in the steel reorganization. Hydro Aluminium held talks with the Government on the feasibility of this plan. If a new plant was built, it would increase Norway's 850,000 tons per year primary aluminum production capacity. About 15% of the present production was

converted into aluminum products in Norway, and the remainder was exported, primarily to Western Europe.

Ferroalloys.—The restructuring and consolidation continued among the Norwegian ferrosilicon producers. Two large electric iron-smelting furnaces (furnaces Nos. 5 and 6) at Mo i Rana, which closed at yearend 1987 because of low iron prices, were converted for ferrosilicon production under the name Rana Metall KS to take advantage of the improving ferroalloy prices. Production from the furnaces was expected to begin in 1989 with the Fesil Group A/S holding a 90% interest in the plant and NJH a 10% interest. This new facility at full capacity was expected to add some 70,000 tons of ferrosilicon production, which was targeted to the global market. The infrastructure and transformers from the old iron plant could be utilized; however, the furnaces were to be rebuilt. Two other furnaces, Nos. 1 and 2, were transferred to Norsk Ferrokrom A/S for ferrochrome production, and Elkem was expected to elect to participate in the company formed to produce this ferroalloy.

Several steel industry plants in Norway experienced problems during the year, which resulted in lost production. A fire destroyed the control room at the Tyssedal pig iron plant and several months were required for repairs. This plant, which was capable of producing 100,000 tons per year, had been only operating at 50% capacity before the fire. A blast in the PEA plant, in Porsgrunn, resulted in the loss of 8,000 to 10,000 tons of siliconmanganese and resulted in increased market prices due to the lost production in the already tight European market. This production loss could not be offset by Elkem's plants at Sauda in Norway or from North America, because these plants were operating at full production capacity. Elkem considered the expansion of high-purity silicon capacity at its Bremanagar plant, and the conversion of a 5,000- to 6,000-ton-per-year fur-

nace to high purity silicon production at the Meraker plant. Another unutilized 10,000-ton-per-year capacity, which exists at this same plant, however, was not considered for utilization.

Silicon metal was produced by Elkem in Norway from three plants (Bremanger, Fiskaa, and Meraker) with 100,000-ton-per-year capacity. The high-grade quartz ores were imported from Spain. Elkem produced about 27% of the Western World's market; the company was experiencing increasing competition from South American and Chinese sources. Elkem has been losing market shares in the United States, which received more imports from South America. In the Japanese market, Elkem's market was increasingly influenced by Chinese exports. Due to this competition, Elkem has redefined its product market to the higher quality metals and to the requirements of the chemical industry.

Gallium.—Elkem was estimated to produce 10% of the world's gallium from a 5-ton-per-year, 99.95% purity gallium metal plant at its Bremanger ferrosilicon smelter facility in Norway. This plant received the gallium waste products from its two aluminum smelters in Norway. Elkem also owned 87% in the British company Crystalox Ltd. and was developing its own patented gallium refining process at its plant in the United Kingdom. This company was associated with the Oxford academic environment and employed approximately 30 people, specializing in advanced refining equipment and crystal growth technology. The refined material is used to manufacture gallium arsenide for use in fast semiconductors that are less vulnerable to the effects of radiation.

Iron Ore.—A/S Sydvaranger produced 44,000 tons less pellets in 1988 and experienced further decreases in output for a variety of factors. The removal of a large amount of overburden from the Ostmalmen and frost

constriction in the ore bins constrained the delivery of ore. Mine production was down to 3,046,000 tons from 3,393,000 in 1987. Bjornevatn North contributed 41.3% of the 1988 production total before the mine was closed and access to Bjornevatn East was opened. Bjornevatn East and Jerntoppen (35.5% and 23.2% of 1988 production, respectively) were the only two mines operating at yearend. Average magnetic iron content was 31.1%, up from 29.29% in 1987; 2.2 tons of rock were mined for each ton of concentrate. The company was anticipating a 15% increase in pellet price for 1989. The company has devoted funds for research and development of new products from its quality iron ore. The company has succeeded in developing "super ore concentrate" for making iron powder and has begun construction of a plant where production was expected to in 1989.

The iron ore operations of A/S Norsk Jernverk (NJ) (Rana Gruber) in the Mo i Rana area were realigned under the same Parliamentary reorganization as the steel industry. The closure of the ironmaking plant at Norsk Jernverk will weaken the financial strength of mining operations at Rana Gruber. The iron ores, hematite and magnetite, quarried in the Dunderland valley at Ortjell were concentrated at a plant in Mo i Rana, an ice-free harbor, an important factor for the export of the iron concentrates through the new terminal completed last year. Even though the supply of concentrates exceeded demand, a 13% price increase had been negotiated for the ore, which was especially important since the largest customer, Rana Gruber iron works, was realigned out of ironmaking. The 7.03 million tons of ore quarried in 1988 yielded 1 million tons of concentrates, down from the 1.4 million produced in 1987, owing to periods of low concentrate production.

The other remaining Norwegian iron ore producer, a private firm, was the smaller Fosdalens Bergverks A/S.

Magnesium.—A modernization and streamlining program was initiated at the Norsk Hydro Porsgrunn production facility because more stringent environmental standards were imposed to reduce chlorinated hydrocarbons discharge into the water. The plant production was reduced from 60,000 to 50,000 tons per year owing to the dismantling of some older units. The cost of the modernization was to be realized through increased productivity and reduced production costs. Furthermore, the worldwide market conditions were positive for magnesium as production capacity was fully utilized and a 7% projected growth was expected. To meet future requirements and take advantage of the Free Trade Agreement between Canada and the United States, Norsk Hydro decided in 1987 to construct a new plant at Becancour in Quebec, Canada. The 40,000-ton-per-year primary magnesium plant cost more than estimated; its targeted completion date, which was slated for summer 1989, was not met. Also, additional capital would be required to increase the capacity to the planned 60,000-ton-per-year rating. This additional capacity in Canada would increase the company's rated capacity to 100,000 tons of the total 250,000 tons of magnesium consumed in the Western World. Norsk Hydro has been a strong promoter of the use of magnesium in other industries, such as structural casting and desulfuring of iron and steel.

Nickel.—Falconbridge Ltd. signed a contract with two Yugoslav companies to take delivery of nickel matte from the Soviet complex at Norilsk for the Kristiansand refinery in Norway. The 3-year contract is for a minimum of 20,000 tons per year of matte of 40% nickel and 35% copper.

Steel.—The crude steel production increased to 723,000 tons from the 654,000 tons produced in 1987. However, the electric steelmaking and roll-

ing plants at Christiania Spigerverk were scheduled to be closed on July 1, 1989, as was the iron-based steelmaking facility at Mo i Rana. Other operations involving wire, nails, and reinforcing products at Christiania were to continue. The export market offset the sluggish domestic market, which showed a 7% drop in reinforcing steel demand down from 225,000 to 210,000 tons and a beam demand down 25%. Sales for ship building sections increased 40%; however, the North Sea market was poor in 1988. The modern rolling mill at Ytre Laksevag near Bergen, which produced tinplate, passed the 100,000-ton production mark. Most of the production was slated for the export market for canned foods usage. The hot-rolled strip prices increased 15% to 20% and contributed to a turnover of almost \$15 million. Wire and nail production by Christiania Spigerverk A/S from plants at Nydalen, Mandal, and Hinnavagen was sluggish, owing to the low construction and industry activity in Norway and to irregular deliveries of raw materials to the plants toward yearend.

Zinc.—A/S Sydvaranger's 75-year-old Killingdal Mine and the Bergverkselskapet Mine were closed permanently in the past for economic reasons. Sydvaranger's other zinc mine, A/S Bleikvassli Gruber, continued operating and showed good results owing to higher prices of the product. From the 162,328 tons of crude ore production, 11,423 tons of zinc, and 5,072 tons of lead concentrates were produced, up slightly from the 162,611 tons produced in 1987. The remainder of Norway's concentrate was produced by Orkla-Borregard A/S; that production was to cease on December 31, 1988. Folldal Verk A/S and Norsulfid A/S were the two companies affected. The 50% ownership in Norsulfid A/S was transferred to Outokumpu Oy. Norzink A/S production in its Eitheim Smelter at Odda encountered fewer operating and startup problems than experienced last year. As a result, annual

production was increased to 122,127 tons of zinc metal. The company operated profitably due to the increased demand and price of zinc, earning \$15.7 million. Zinc dust from the Larvik Group turned out to be the most profitable; however, zinc oxide also improved over last year. Production of zinc dust and oxides was 12,586 tons. Total sales for Norzink increased to \$165 million from the \$123.5 million in 1987. The company stated concerns about increases in the future price of power.

Industrial Minerals.—Cement.—A/S Norcem, Norway's only cement producer, merged with Aker Engineering A/S to form A/S Aker-Norcem, Norway's largest privately owned industrial group and largest offshore petroleum construction and contracting company. Cement production increased significantly at the Dalen plant in Brevik, as a result of plant modernization. Concern about pollution had prompted the additional purchase of pollution control equipment at the plant.

Feldspar and Nepheline Syenite.—Norfloat A/S was one of Western Europe's major suppliers of feldspar and continued to account for at least 80% of Norway's production. Its pegmatite quarries and beneficiation plant were near Lillesand about 20 miles east of Kristiansand in southern Norway. Mined and comminuted raw material is processed into its mineral components, sodium feldspar, potassium feldspar, quartz, and byproduct mica by flotation and magnetic separation. The reserves were estimated to be large. Production, mostly for export to Western Europe's glass and ceramic industries, was 35,000 tons of sodium feldspar and 28,000 tons of potash feldspar.

Norsk Nefelin, a mining entity owned by Elkem, produced approximately 270,000 tons per year from its efficient underground mine on the island of Stjernoy in the Alta Fjord in the Norwegian Arctic. The comminuted and screened ore was purified by magnetic separation.

As Western Europe's only producer of nepheline syenite with major reserves, the company was the major supplier of the product to the glass and ceramics industries of Western Europe, especially in the Federal Republic of Germany, the United Kingdom, France, and Belgium and Luxembourg, in order of volume. The glass industry was the major user for the profitable operation. A new product, micronized nepheline syenite, had received a positive response in the paint-filler market.

Megon & Co. A/S operated a 30- to 50-ton-per-year yttrium and scandium oxide extraction plant at Kjeller, near Oslo. The two rare-earth oxides used in red phosphors and lasers could have further applications in superconductors.

Fertilizers.—Norsk Hydro, the world's largest fertilizer producer, was contemplating the construction of a new world-class ammonia plant in Norway to utilize North Sea gas. North Sea gas landed at Karsto or associated gas from the new oilfields in the Haltenbanken area would provide the feed stock for the proposed plant in Porsgrunn. The increase in the present plant's capacity from 360,000 tons per year to 900,000 tons per year and a switch to methane from the ethane and propane presently used was to begin in the mid-1990's. Last year a plant commissioned in the Netherlands reduced the company's ammonia deficit to 10%. However, this new plant was to provide other economic advantages by replacing older less efficient capacity, for example, a 115,000 electric ammonia unit at Rjukan that had been uneconomic and had produced under its capacity for several years, and the electrolytic (120,000 tons per year) plant at Glomfjord, which was due for closure and its electricity diverted to other projects. This newly enlarged Porsgrunn plant was to be the only remaining Norwegian ammonia plant. Norsk Hydro planned to close plants in Sweden (60,000 tons per year at Koping) and in France (250,000-ton-per-year plant at Pierrefitte, operated by the subsidiary Co-

faz renamed Norsk Hydro Azote). The closure would represent a 25% decrease in Hydro's ammonia production in France. Also scheduled to close were three units for nitric, sulfuric, and phosphoric acid at Ambares. This closure was to coincide with the startup of a new unit at Ambes. The 1,150-ton-per-day nitric acid and 1,500-ton-per-day ammonia nitrate facilities were to be built by NSM of Belgium. The rationalization by Norsk Hydro represents a trimming of losses by the subsidiary, Cofaz. Norsk Hydro's other European ammonia production includes a 550,000-ton-per-year plant in the Federal Republic of Germany, 700,000 tons per year in France, and a 1,500,000-ton-per-year plant in Sluiskil in the Netherlands.

Quartz.—Minnor A/S, an ill-fated joint venture started in 1987 at Drag in northern Norway, was to produce ultrapure quartz for the electronics industry. The project was cancelled due to the difficulty in attaining the degree of purity required, and production ceased. Microsilica, a very fine silicon dioxide dust, a waste byproduct produced by Elkem, was sold to a variety of different industries for uses in plastics, concrete additive, and insulation.

Titania.—The \$170 million TiO₂ slag plant at Tyssedal produced approximately 10% of the world's supply of TiO₂ from its electrical smelting furnace. The plant had been designed by Elkem to produce 108,000 tons per year of high-purity pig iron in addition to 200,000 tons per year of 75% TiO₂ slag. Feed material was to be a 44% TiO₂ ilmenite concentrate mined and beneficiated by the U.S.-owned Titania A/S in southern Norway. The slag produced from this concentrate can be converted to TiO₂ pigment only by the sulfate process and is not suitable for conversion by the more environmentally acceptable chloride process. KSI and Titania, a minority owner of KSI, sponsored research at the University of Trondheim to overcome this problem

associated with Titania's ore. Technical problems had delayed the full production from the plant and the Government was requested to provide additional funds of \$30.3 million until the plant is working satisfactory.

Mineral Fuels.—Coal.—Store Norsk Spitsbergen Kullompani A/S, the Government coal operation, continued to produce coal on the island of Spitsbergen. This island, which is north of the Arctic Circle, had only two mines in operation after a smaller and newer coal mine at Svea ceased operations owing to deficit problems. This mine was being maintained, however, and the company duties were being split between the Federal and local governments. In general, the coal requirements of the Norwegian steel industry were reduced owing to restructuring and elimination of the iron ore base steel industry at Mo i Rana. The coal production was down from the 400,000 to 500,000 tons produced in recent years to only 275,000 tons produced in 1988.

Natural Gas.—In 1988, the Norwegian Petroleum Directorate estimated a decline in net remaining reserves as compared to previous years. The net reserves in 1988 were estimated to be 723 million barrels of oil less; however, net gas reserves increased by almost 10,000 billion cubic feet to 83.3 trillion cubic feet. The natural gas produced in the Norwegian waters was either reinjected into one of the oilfields to improve recovery from that field or transhipped by one of three pipelines to shore. Viability of gas projects in the central North Sea ultimately could depend on negotiations started in 1988 between British Gas and Den Norske State Oljesselskap A/S (Statoil) representing the group of Norwegian gas producers. The new gasfields anticipated to be of significance were Sleipner and Troll Fields. Statoil let the contract for Sleipner's gravity base for the platform, which was scheduled to

produce 725 million cubic feet per day of gas and 125,000 barrels per day of liquids in 1993, and the Norsk Shell's Troll project, which was to provide gas in 1996. The gas was to be transmitted through the Zeepipe connecting these fields to Zeebrugge in Belgium. The Storting approved this operational plan for the group to lay the 40-inch line. However, the heavily indebted Statoil was reported reconsidering the \$2.3 billion project to develop Sleipner Field. Troll Field, the much larger field, and its associated pipeline, estimated to have cost \$60 billion at 1986 dollars, was less valuable to the company as gas prices weakened.

A large portion of Norway's natural gas continued to be sold through the Frigg collection and transmission system. An agreement between Norway and the United Kingdom on the joint exploitation of the Frigg Field established the Norwegian share of the field at 60.82%. Production from the Norwegian, East Frigg Field and the British Alwyn Field was added to the system in 1988, joining the other offset Norwegian fields of North East Frigg and Odin. The Frigg Field production had apparently begun to decline in 1987 and was anticipated to be depleted in the first part of the 1990's. From the initial 2.5 million barrels of oil and 3,743 billion cubic feet of gas (Norwegian share of reserves), 1,258 million barrels of oil and 247 billion cubic feet of gas remain; this was barely 50% of the oil and 6.6% of the gas. Total remaining reserves from Norwegian interests of the Frigg complex (Norwegian fields supplying gas for transmission) were estimated to be 1,258 million barrels of oil and 1,299 billion cubic feet of gas. At the pipeline capacity of 2,350 million cubic feet per day, the remaining gas reserves would suffice for only a few years. The British fields of Piper, Tartan, and newly added Alwyn, were not included in the reserves for the 195-mile pipeline from Frigg; the pipeline was completed in 1978.

Statoil began production October 3,

1988, from the Trommeliten Field by subsea completions. The gas production was piped to Edda Field and then on to Ekofisk for processing. The intention was to inject the gas for reservoir preservation and for liquids absorption until 1991, after which the gas was to be piped to Karsto, Norway for local use in a gas-fired power station or other uses.

The largest gasfield in the Norwegian waters to date is the Troll complex, which consists of the Troll West and Troll East structures. Production was estimated to begin in 1996 at the rate of between 582.7 and 752.2 billion cubic feet per year. This production rate would be approximately equal to 66% of the present day rate from the Norwegian sector. This is five times more gas production than that from the next largest field, Ekofisk. The investment in Troll Field was \$3.7 billion by yearend 1988. Actual production was thought to require a novel platform design, probably using reinforced concrete instead of steel because of the great water depth of approximately 1,000 feet and the soft sea floor. The Government decided near yearend 1986 that Shell, Statoil, and Norsk Hydro would share responsibility for operation of the Troll and Sleipner Fields during their development. Interests in the Troll Field development were: Statoil, 50%; Shell, 35%; Conoco, 5%; Mobil, 5%; and Norsk Hydro, 5%. Estimated cost of the Sleipner development project was \$1.9 billion. Sleipner East, which contained about 25% of the total Sleipner reserves, was to be developed first, because some of the gas in other parts of the field contained carbon dioxide. Interest division in this development was as follows: Statoil, 50%; Esso Norge A/S, 40%; and Norsk Hydro, 10%. Sleipner West was also one of the fields under consideration for development; Statoil and the Government were considering the postponement of this field for financial reasons. The Sleipner Gasfield's \$2.3 billion price for development was less

attractive because of falling gas prices. Esso Norge A/S the operator with a large interest in Sleipner West Field, voiced concerns about the delayed development plans.

The first two fields recommended for development in the Haltenbanken area were Heidrun and Draugen Fields. The Storting approved the Draugen development plans in December 1988, for the use of a monocolumn platform with a concrete gravity base structure. Five platform and two subsea wells were planned for the field in over 850 feet of water. The other field, Heidrun, was recommended for staged development by which early subsea production facilities would provide the cash flow and the reservoir experience early in the field development. The plan was for phase 1 to produce 60,000 barrels per day for 3 to 4 years beginning in 1990, followed by the main development of the field in phase 2. Phase 3 would drain the northern areas by subsea completions followed by the last phase. Phase 4 is the draining of the gas cap. The gas in the early phases would be reinjected until a pipeline was laid to the mid-Norwegian coast, around Molde or Trondheim for sales in Scandinavia or a tie-in to other lines. The cost of the pipeline was estimated at \$415 million and the terminal at \$340 to \$850 million. The 280 billion cubic feet per year gas trunkline would allow natural gas liquids to be separated at the terminal; however, the sea-bottom pipeline must be designed to account for conditions of crossing an iceberg scoured ocean floor.

Saga Petroleum A/S was nearly ready to also declare commercial Migard, which is in the Haltenbanken region of the offshore Norwegian waters. This field is important in the overall development of the area, as so far it has the largest recoverable reserves, namely, 4,500 billion cubic feet of gas. The condensate production could account for as much as 110 million barrels of liquids from wells capable of producing at rates of 100 million cubic feet per day and

from the field, which is capable of producing for 15 to 35 years.

Norpipe A/S pipeline connects Ekofisk Field to the European gas market via Emden, Federal Republic of Germany, and oil to the United Kingdom landfall at Tesside.

Petroleum.—Sales revenues decreased and provided only 9% gross national product in 1988, compared to 19% at the peak in 1985. Petroleum sales represented 25% of the exports from Norway.

The estimated remaining petroleum reserves from the Norwegian North Sea amounted to 10.1 billion barrels of oil and natural gas liquids. New petroleum reserves added in 1988 were greater than production; 1.0 billion barrels of new reserves were found, compared to the production of 0.5 billion barrels during the year. However, several producing fields that had reserves changed: Ula oil was up 31%, Oseberg oil was down 7%, Oseberg gas was up 17%, and Statfjord oil was up 8%. About 77% of the North Sea oil reserves were in the Oseberg, Statfjord, Gullfaks, Ekofisk, and Snorre Fields, in order of volume. Phillips Petroleum Co. Norway discovered oil in the Jurassic section below the chalk where most of Ekofisk oil and gas had been found. This was considered a significant discovery and could lead to extended reserves and field life, if commercial reserves were to be defined under existing fields in the Southern North Sea.

In the Oseberg Field, Norsk Hydro completed the concrete gravity platform, installed the offshore unit, and initiated production in December. Initial production was 100,000 barrels per day and was anticipated to peak at 300,000 barrels per day, when the third platform, which was approved earlier in 1988, was installed and on-stream in 1991. The Oseberg Field consists of three structures, Alpha, Alpha North, and Gamma. Because Alpha and Gamma Fields had a gas cap, the pressure maintenance method was changed from water to gas injection for reservoir

preservation. The purchase of 882 billion cubic feet of gas from a Troll Field subsea module for reinjection into the field was estimated to result in the additional recovery of 94 million barrels oil. The oil production was transported to Sture in Oygarden, Norway, via the Oseberg Transport System. This was the first oil landed in Norway and was delivered on December 20, 1988, by the 28-inch 72-mile line from platform A. The line capacity was rated at 400,000 barrels per day with the oil pumps on the platform.

Statfjord, the largest producing oilfield in Europe, accounted for 56% of Norway's crude output in 1988. The production amounted to 850,000 barrels of oil per day from the three production platforms via the associated loading platforms, which transferred oil into tankers. The gas was transmitted to land by either the Statpipe or Norpipe transmission lines.

Statoil's development of the Gullfaks Field proceeded on schedule, with the addition of the B platform in February 1988. Platform A, an integrated drilling and producing unit with a daily capacity of 250,000 barrels of oil, was in 450 feet of water. Platform B, a drilling and water injection unit, was also installed in 450 feet of water. Platform C, the second production unit, was to be placed in 700 feet of water in 1989, increasing the total field production capacity to 485,000 barrels per day in the early 1990's. Oil was to be loaded into tankers, and the gas was to be sent through the Statpipe system via the Statfjord C platform.

Production from Ekofisk, now Norway's third largest producing oilfield, continued to decline and accounted for 10% of total crude production. The fifth phase of development for the field, in response to the field's declining production, was to inject water from platform 2/4-K in 1987. It was estimated to enhance recovery by the production of 170 million barrels of additional oil. Furthermore, the Edda platform was modified to inject gas

from the Tommeliten Field into the reservoir in an attempt to maintain reservoir pressure, which caused the field subsidence of 14 feet. Due to the subsidence, additional plans were made to expand the water injection project to the southern portion of the field as well as to the upper reservoir. The recovery of an additional 1,164 million barrels of oil was anticipated. The feasibility of injecting nitrogen into the reservoir also was being studied for pressure maintenance of the field and to counteract the subsidence. In 1987, field subsidence had continued with no significant decrease in the rate of subsidence despite the injection of 108 billion cubic feet of natural gas into the field during 1985 and 1986. This injection project was terminated in October 1986, when total subsidence reached 12.5 feet. Production continued, and a decision was made by the operator, Phillips Petroleum Co. Norway A/S, to mechanically raise the platform in summer 1987 at a cost of \$.5 billion. Furthermore, Phillips elected to construct a 448-foot diameter concrete wall around the main Ekofisk production storage tank to protect the facilities from the subsidence.

Snorre Field, operated by Saga Petroleum A/S, was to be the first tension legged platform in the North Sea. This new type of production platform was to be placed in the southern portion of the field first. As of December 31, 1988, approximately \$151.5 million had been invested in the field, where the water depth is over 960 feet. The oil produced was to be piped to Statfjord for processing and loading.

The Ula Field reserve estimates had increased 59% since 1987; a 31% increase in 1988 represented an additional 75.5 million barrels oil. The gas produced was transmitted via Cod Field to Ekofisk. The Ula pipeline, which was laid in 1984 to Ekofisk, transmits the oil to Ekofisk Center and into Norpipe for landing at Teesside.

Statoil's Veslefrikk Field, which had a 65,000 barrels per day floating pro-

duction unit, was on schedule, and first production was in 1989. The 226 million barrels oil reserve field was a combination of a fixed steel wellhead platform and floating production facilities connected by a flexible bridge. The drilling platform West Vision was to be converted for the field production facilities. The oil was to be delivered to Oseberg by a new pipeline for further transmission through the OTS.

The Murchison Field interest was adjusted, and the Norwegian interest decreased from 25.06% to 22.2%; this resulted in a Norwegian production share of only 10,000 barrels per day. The liquid fraction was piped through to Brent Field in the United Kingdom sector for transmission to the Shetlands.

Oil production from Valhall, which has produced since 1982, was to be boosted by the production tie-in of Hod Field 8 miles south. The tie-in would access additional reserves of the 25 million barrels of oil by the use of an unmanned platform. The production was to begin in 1990 and was to be controlled from Valhall; the product was to be sent by two phase flow to Valhall for processing.

Statoil, the Government company, needed to reduce indebtedness as it approached 90% capitalization. One of the problems was the number, size, and interest of costs in offshore development projects, and the cost of the large Mongstad refinery and terminal project. This modernization cost \$1 billion more than had been expected.

SWEDEN¹⁰

The Swedish economy continued its strong performance in 1988. The GDP increased 2.8% to \$179 billion,¹¹ industrial investment increased 10% to \$6.6 billion, industrial production rose 4%, and the jobless rate decreased 1.6%. The budget outcome, which in 1982 stood at a deficit of 13% of the GDP, came out of the red and showed a

surplus of 1% of the GDP for the first time in 25 years. The price paid for this prosperity was an inflation rate of 6.5%, which was 2% to 3% higher than that of competitive countries. A weakening balance of payments was reflected in the current account balance, which was a negative \$2.2 billion at yearend.

Sweden has relaxed its foreign exchange controls in recent years so that only minimum requirements remain. The Government intends to remove all foreign exchange regulations except those required for tax and statistical information. Final deregulation was expected in mid-1989 when permission will be granted for foreign banks to establish branch offices in Sweden.

The mineral industry accounted for approximately 3% of Sweden's GDP. More than 90% of the value of the \$5 billion per year industry was metals mining, smelting, and refining. Industrial minerals made up the remaining 10%. Steel continued to account for the majority of the value of the metals industry, followed by iron ore, ferrochrome, aluminum, and copper, in order of value. Cement, crushed stone, and sulfur were the major industrial minerals produced.

Production and Trade

Although there were no significant changes in the mining industry, there was an increase in capital investment. This was part of an ongoing effort to improve productivity and efficiency. Major efforts were directed toward automation and mechanization. Complex sulfide ores and gold ores were the main targets of increased prospecting, exploration, and development work.

The Swedish Government announced it had allocated \$3.5 million to Boliden Minerals AB's mining expansion program, with further guarantee of an additional \$16 million to be paid by 1999. Sweden's Ministry of Trade and Industry and Boliden agreed in March 1988 on the development of 15 mining projects in northern and central Sweden. The total

cost of the project was estimated at \$300 million. As a result of the program, ore production, mainly copper and gold, was expected to rise 10%. Boliden was planning to invest approximately \$500 million into 21 mining projects including exploration, new mines, and concentrator plants, over the next 10 years. Boliden operated 16 mines and 8 concentrators at yearend.

Namden for Statens Grävverksamhet (NSG), Sweden's state mining board, announced that it was considering two companies, Newmont Mining Co. of the United States and Outokumpu Oy of Finland, to develop the copper and gold deposit at Pahtohavaare in Swedish Lapland. The value of the Pahtohavaare ore deposit was estimated by NSG to be worth \$250 million.

Trade is vital to Sweden. The country's combined imports and exports of goods and services account for almost two-thirds of its GDP. Total Swedish exports of goods grew 3.7%. Exports of manufactured goods grew almost 5%. Exports of nonferrous metals rose but petroleum derivatives exports fell sharply.

Sweden's import of crude oil decreased 7% in volume and 26% in value. Import volume of refined products rose 4%, but decreased in value 9%. Total import volume of petroleum products went down 4%, and value dropped 20%. This decrease in value is attributed to the lower 1988 oil prices.

The import of natural gas steadily increased. Natural gas imports increased 100 million cubic meters, and totaled 373 million cubic meters. Sweden's sole supply of natural gas came from the Danish North Sea Field Tyra. Talks with two other potential suppliers, the U.S.S.R. and Norway, were progressing as the natural gas pipeline network was being extended closer to Stockholm on Sweden's east coast.

By 1989, all energy producing plants burning fossil fuels will have a ceiling for sulfur emissions of 0.19% sulfur per megajoule of fuel. This corresponds to an 0.8% sulfur content in

residual heating fuels. By 1993, all oil, peat, and coal-fired plants will have stricter emission requirements: Plants with annual emissions of more than 400 tons of sulfur will be restricted to 0.05 gram sulfur per megajoule of fuel; other plants will be restricted to 0.10 gram sulfur per megajoule of fuel.

Commodity Review

Metals.—Copper.—After securing the Government's official financial backing, Boliden proceeded with a mining package of 15 projects. The plan's main objective was copper production, which was expected to increase by around 10,000 tons per year over the next 4 years. Boliden's goal is to obtain target of securing 50% of the feed for its 85,000-ton-per-year Ronnskar copper smelter with ore produced by company mines. A major part of the package involves extending the life of the Aitik copper mine by about 10 years and boosting production from 11 to 14 million tons per year. This project was scheduled to be completed by 1991. Other projects include development work at Akersborg, Kedtrask and Kankberg, and deepening mines at Boliden, Kristineberg, and Garpenberg.

The new ore dressing plant at Stora Kopparbet AB's Falun Mine, which was completed in midyear, will treat ore from the Falun Mine and the Svardsjo Mine. The plant was redesigned to increase capacity from 200,000 to 250,000 tons per year of ore. The plant, considered to be the most modern in Sweden, utilizes autogenous grinding. The plant can handle almost any ore mined by the company and incorporates the latest in environmental technology.

Ferrochrome.—Swedechrome AB brought its new plasma arc high-carbon ferrochrome smelter in Malmo to 50% of production capacity after overcoming operational problems earlier in the year. The problems were mainly with subsidiary systems such as dust control, gas coolers, and injection equipment. A new

dust recirculation system was installed to meet stringent environmental regulations. The company expects the plant to reach its full operating rate of 80,000 tons per year by yearend 1989.

Gold.—Terra Mining AB officially opened its Bjorkdal open pit mine in October 1988 at Hebbefors in northern Sweden. Terra Mining is owned 50% by Norsk Hydro, 35% by Euroventures Nordica A/S, and 15% by Christer Lofren. Production at the mine was estimated to be around 32,000 troy ounces per year. Proven reserves were estimated to be 1.5 million tons averaging 0.1 ounce of gold per ton.

Boliden Minerals planned to begin developing its Akerberg gold deposit in northern Sweden in the first part of 1989. The drilling program had outlined 1 million tons of ore containing an average grade of 0.1 ounce of gold per ton. Current plans are for an open pit mine, expected to produce 20,000 ounces of gold per year. The Akerberg ore would be processed at the nearby Enasen plant.

Boliden also was planning a \$4 million drilling and seismic program at Petiknes, near the Akerberg site. The company had located promising gold mineralization in an estimated 1 million tons of ore. The mineralization is 200 meters below surface and would require development of an underground mine. Boliden produces about 112,000 ounces of gold per year, mostly as a byproduct from its complex ore bodies, which primarily contain copper and zinc.

Iron Ore.—Loussavaara Kiirunavaara AB (LKAB), Sweden's major iron ore producer, increased production 11%. The largest source of this production was the Kiruna operation, including the Svappavarka Mine. The remainder was produced at the Malmberget operation. Development work at the Kiruna Mine was increased 40%. Similar work is to be done at the Malmberget Mine in 1989. LKAB was planning to increase

TABLE 10
SWEDEN: PRODUCTION OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity		1984	1985	1986	1987 ^p	1988 ^q
METALS						
Aluminum:						
Primary		82,771	83,509	77,667	81,480	98,597
Secondary		17,557	17,545	18,144	8,820	18,000
Arsenic: Trioxide, refined ^q		10,000	10,000	10,000	10,000	10,000
Copper:						
Mine output, Cu content		86,898	90,495	87,387	85,016	82,600
Metal:						
Smelter:						
Primary		79,775	74,668	83,358	92,909	75,600
Secondary		22,895	26,017	19,142	12,669	14,700
Total smelter		102,670	100,685	102,500	105,578	90,300
Refined:						
Primary		56,440	46,997	68,688	80,877	74,700
Secondary ^q		7,464	17,655	15,773	11,028	12,000
Total refined		63,904	64,652	84,461	91,905	86,700
Gold:						
Mine output, Au content	troy ounces	141,600	148,900	^q 130,000	^q 130,000	135,000
Metal, primary ²	do.	106,200	138,000	^q 120,000	^q 120,000	120,000
Iron and steel:						
Iron ore and concentrate:						
Gross weight	thousand tons	18,123	20,454	20,489	19,707	³ 20,440
Fe content	do.	11,780	13,500	13,520	13,006	13,470
Metal:						
Pig iron and sponge iron	do.	2,323	2,523	2,539	2,314	2,494
Ferroalloys:						
Ferrochromium		134,028	135,453	126,144	111,815	110,000
Ferrochromium-silicon		30,633	26,243	17,024	—	—
Ferromolybdenum		229	161	—	—	—
Ferrosilicon		23,278	28,279	19,969	19,949	20,000
Ferrotungsten		180	—	—	—	—
Total		188,348	190,136	163,137	131,764	130,000
Steel crude	thousand tons	4,705	4,813	4,710	4,595	4,779
Semimanufactures, rolled	do.	3,988	4,254	4,005	^q 4,000	4,100
Lead:						
Mine output, Pb content		80,760	75,894	88,903	90,423	91,000
Metal:						
Smelter:						
Primary:						
Crude		15,878	15,535	6,512	1,439	1,500
Refined		49,758	43,221	49,160	61,229	62,000
Total primary		65,636	58,756	55,672	62,668	63,500

See footnotes at end of table.

TABLE 10—Continued
SWEDEN: PRODUCTION OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity	1984	1985	1986	1987 ^P	1988 [*]
METALS—Continued					
Metal—Continued					
Smelter—Continued					
Secondary	27,737	25,861	27,783	30,185	32,000
Total smelter	93,373	84,617	83,455	92,853	95,500
Refined:					
Primary	49,758	43,222	49,160	61,229	60,000
Secondary	27,737	25,861	27,783	30,185	30,000
Total refined	77,495	69,083	76,943	91,414	90,000
Molybdenum, oxide, roasted, Mo content	1,064	1,486	2,170	2,121	2,000
Selenium, elemental, refined	68	46	^a 50	^a 50	50
Silicon metal	20,206	19,755	^a 20,000	^a 20,000	20,000
Silver:					
Mine output, Ag content thousand troy ounces	7,676	7,442	7,555	6,912	6,211
Metal, primary ² do.	5,370	5,073	^a 5,250	^a 4,800	4,600
Tungsten, mine output, W content	385	402	357	574	320
Zinc: Mine output, Zn content	210,037	216,403	219,289	218,570	³ 186,900
INDUSTRIAL MINERALS					
Cement, hydraulic thousand tons	2,393	2,124	2,119	2,238	2,200
Clays: Kaolin	196	106	60	^a 100	100
Feldspar, salable, crude and ground	49,833	41,720	35,160	34,226	36,000
Fluorspar concentrate	3,454	3,169	265	220	³ 225
Kyanite	—	2,200	^a 5,000	^a 5,000	6,000
Lime, mostly quicklime thousand tons	648	649	656	590	400
Nitrogen: N content of ammonia do.	49	18	46	41	(⁴)
Phosphate rock (byproduct):					
Gross weight do.	133	187	192	221	³ 142
P ₂ O ₅ content do.	51	71	71	82	60
Pyrite, gross weight do.	418	407	447	429	³ 355
Quartz	17,539	17,298	^a 17,000	^a 17,000	18,000
Sodium sulfate ^a thousand tons	100	100	100	100	100
Stone:					
Dimension, mostly unfinished:					
Granite thousand tons	138	148	169	135	140
Limestone do.	15	15	^a 15	^a 15	20
Sandstone do.	4	3	^a 3	^a 3	5
Slate do.	22	21	21	20	20
Crushed:					
Dolomite do.	830	963	780	606	600
Granite do.	9,873	8,060	6,888	7,313	7,200
Limestone:					
For cement manufacture do.	842	765	913	943	950

See footnotes at end of table.

TABLE 10—Continued
SWEDEN: PRODUCTION OF MINERAL COMMODITIES¹
(Metric tons unless otherwise specified)

Commodity		1984	1985	1986	1987 ^a	1988 ^a
INDUSTRIAL MINERALS—Continued						
Stone—Continued						
Crushed—Continued						
Limestone—Continued						
For lime manufacture	do.	687	1,997	*2,000	*2,000	2,000
For other construction and industrial uses	do.	2,039	2,068	*2,100	*2,100	2,000
Chalk (ground)	do.	40	40	39	37	38
Marl	do.	2,718	2,314	*2,500	*2,500	2,500
For agricultural uses (ground)	do.	296	306	300	*300	300
For other uses (ground)	do.	108	94	*100	*100	100
Total	do.	6,730	7,584	7,952	*7,940	7,888
Quartzite	do.	1,533	1,466	7,128	1,297	1,400
Sandstone	do.	138	123	*125	45	50
Other	do.	666	690	*700	*700	700
Sulfur:						
S content of pyrite	do.	212	210	227	*220	200
Byproduct:						
From metallurgy	do.	122	123	125	*130	125
From petroleum	do.	26	23	49	*50	45
Total	do.	360	356	401	*400	370
Sulfuric acid	do.	930	960	1,001	985	1,000
Talc and steatite		17,882	14,400	2,000	16,981	16,000
MINERAL FUELS AND RELATED MATERIALS						
Carbon black	thousand tons	26	31	*30	*30	30
Coke, metallurgical	do.	1,236	1,247	*1,200	*1,200	1,200
Peat, for agricultural use ^a	do.	60	60	60	60	60
Petroleum:						
Crude	thousand 42-gallon barrels	98	60	30	24	15
Refinery products:						
Liquefied petroleum gas	do.	1,891	2,088	2,714	2,448	2,500
Naphtha	do.	1,700	1,096	1,530	1,726	2,640
Gasoline, motor	do.	27,931	25,466	26,868	*31,118	37,600
Jet fuel	do.	3,784	4,112	3,544	*4,704	6,600
Kerosene	do.	116	202	170	*256	395
Distillate fuel oil	do.	34,137	34,480	40,761	41,552	44,230
Residual fuel oil	do.	27,999	27,206	28,025	26,207	25,785
Other	do.	4,853	5,252	5,485	5,872	6,000
Refinery fuel and losses	do.	5,175	8,010	6,630	7,448	7,500
Total	do.	107,586	107,912	115,727	*121,331	133,250

^a Estimated. ^b Preliminary.

¹ Table includes data available through July 1, 1989.

² Includes only that recovered from indigenous ores excluding scrap.

³ Reported figure.

⁴ Plant closed.

pellet-making capacity in its three plants in Kiruna, Malmberger, and Svappavarka by about 700,000 tons per year. When expansion is completed, the company's overall pellet capacity will be 11 million tons per year.

Mining operations ceased at Svappavaara for 5 weeks in midyear. LKAB extensively rehabilitated the plant and installed new equipment. The pellet plant capacity was increased to 3.3 million tons per year. New equipment for loading pellets onto railway cars was installed. A fluorine flume purification plant and exhaust gas recovery furnace also were constructed.

Silicon.—KemaNord decreased silicon production at its Ljungkavark plant from 24,000 tons per year to 14,000 tons per year in the last quarter of 1988. The company was unable to negotiate a lower cost power contract with the Government. The Government's new energy policy aims to increase the average price of power for the industry by 33% to 35% over the next 3 years. The company, whose power contract expired at yearend, maintained that it could not absorb escalating energy costs. KemaNord shut down one of its two furnaces and announced that it was switching its emphasis to high-grade silicon used in the chemical and aluminum industries.

Steel.—After a relatively slow year in 1987, business increased for the Swedish steel industry. The industry operated close to capacity. Most companies showed profits. Companies made substantial investments in environmental protection equipment to meet stricter operating criteria.

In early 1988, a new steel group was formed when Welbond AB was created from Smedjebacken-Boxholm AB, Halmstad Jarnverks AB, and Forsbacka Jernverk AB. The Welbond Group, now with the name Fundia AB, is scrap based and was expected to be a major manufacturer of long steel products in commercial grades.

Svenskt Stal (SSAB) implemented a reorganization prior to a public stock issue, the date of which was unknown at yearend. SSAB planned to concentrate on strip mill products. New divisions instituted were SSAB Strip Mill AB, SSAB Heavy Plate AB, and SSAB Bar Steel AB.

SSAB announced its decision to close several units in 1989 including the electromelting shop and wire rod mill at Domnarvet, the small section mill and two continuous casting machines at Lulea, and the hot strip mill at Surahammer. These shutdowns were expected to result in the loss of 2,500 jobs.

The proposed closure of SSAB's two electric arc furnaces at Domnarvet and Ovako Steel Oy AB's electric furnace at Hallefors would cut ferrous scrap import requirements by around 500,000 tons per year. Because Sweden imports around 750,000 tons per year, import requirements would drop to around 250,000 tons per year. The export ban on Swedish scrap could be lifted when the closures take place.

Industrial Minerals.—Cement.—The cement producer Allentown Cement Co. and the ready-mixed concrete manufacturer Vineland Co., both of the United States, and Castle Ltd. of the United Kingdom were purchased by the Euroc group of Sweden and the Aker Group of Norway. The international diversification by Aker and Euroc was coordinated through the joint venture Scancem AB. The establishment of Scancem resulted in the formation of one of the largest international cement enterprises. By acquiring Castle Cement, Scancem gained 25% of the United Kingdom's cement market. Both U.S. companies are also strongly positioned in their U.S. markets.

Mineral Fuels.—According to Vattenfall, the state power authority, Sweden faces the prospect of a doubling of cost of energy production. A major cause of this price increase is the planned phaseout of its nuclear power

program. This phaseout is to start in 1995. Nuclear power currently accounts for about 50% of the country's energy supply. Vattenfall estimated that energy prices would increase 40% by the mid-1990's. The effect of the higher prices would be felt across a wide range of services. Two reactors due to be closed by the mid-1990's include one of four at the Ringhals station and one of two at Barseback. Forestry, metals, and mining industries would be hit particularly hard.

Sweden plans to buy natural gas to replace the nuclear energy power stations. Negotiations were underway at yearend between Vattenfall, the Finnish state owned oil company Neste Oy, Norway's Statoil, and the U.S.S.R. To justify the cost of a pipeline from the Norwegian gasfields, Neste estimated a market of 5 billion cubic meters per year would be required. Through this pipeline, Sweden would be connected to the European gas grid, which would act as a stabilizing price factor for Sweden's industry that competes with the EC market.

Swedegas and Neste Oy held discussions to determine volumes and prices for Soviet gas via pipeline from Finland to Sweden. A Baltic Sea crossing from Uusikaupunki to Gavle, chosen as the best route for the pipeline, was estimated to cost \$242 million.

There was renewed interest in Baltic Sea petroleum prospecting after seismic investigation confirmed oil deposits of an estimated 60 million barrels. Two Swedish oil companies, Hydrocarbon International (HCI) and Gotlandsolja AB (GOAB), formed Grauten Oil AB. The company will drill for gas and oil deposits in the Baltic Sea sector and on the island of Gotland. Grauten expects to perform 110 test drillings over the next 3 years at an estimated cost of \$3.3 million.

¹ Prepared by Donald E. Buck, Jr., physical scientist, Division of International Minerals.

² Where necessary, values have been converted from Danish krone (DKr) to U.S. dollars at the rate of

DKr7.02 = US\$1.00, the average for 1988.

³ Prepared by Donald E. Buck, Jr., physical scientist, Division of International Minerals.

⁴ Prepared by Harold R. Newman, physical scientist, Division of International Minerals.

⁵ Where necessary, values have been converted from finnmærk (Fmk) to U.S. dollars at the rate of Fmk4.19 = US\$1.00, the average rate for 1988.

⁶ Prepared by Harold R. Newman, physical scientist, Division of International Minerals.

⁷ Where necessary, values have been converted from Icelandic krona (Ikr) to U.S. dollars at the 1988 average rate of Ikr43.00 = US\$1.00.

⁸ Prepared by Donald E. Buck, Jr., physical scientist, Division of International Minerals.

⁹ Where necessary, values were converted from Nor-

wegian kroner (NOK) to U.S. dollars at the rate of NOK6.6 = US\$1.00, the average for 1988.

¹⁰ Prepared by Harold R. Newman, physical scientist, Division of International Minerals.

¹¹ Where necessary, values have been converted from Swedish kronor (SKr) to U.S. dollars at the rate of SKr6.12 = US\$1.00, the average for 1988.